ALFRED

microwave amplifier

5000 SERIES 515

MANUAL # 110-6014

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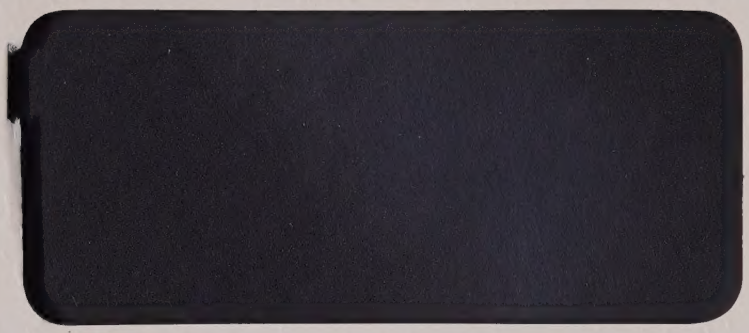
INSTRUMENTATION



INSTRUCTION MANUAL

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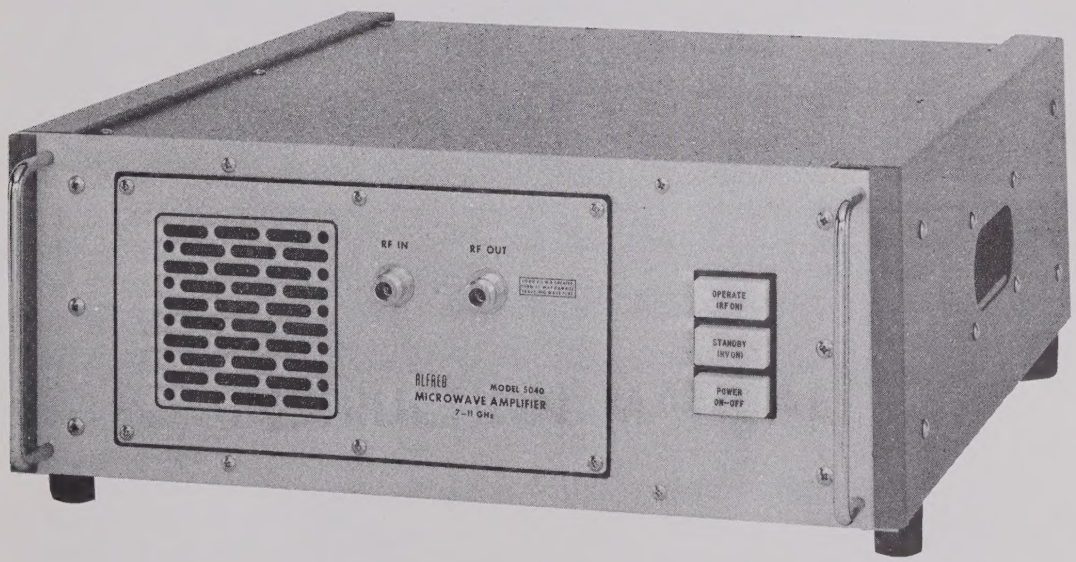

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SINGER
INSTRUMENTATION

The Singer Company, Palo Alto Operation

3176 Porter Drive, Palo Alto, California 94304/ (415) 493-3231 TWX 910-373-1765

WARRANTY

THE SINGER COMPANY, PALO ALTO OPERATION, warrants each instrument sold by it to be free of defects in material and workmanship, effective from the date of shipment to the original purchaser for a period of 1 year except where a specific warranty period is stated in the operating manual. Microwave tubes used in standard instruments carry the best available service warranty, a copy of which is available on request.

The Seller will not be liable for incidental or consequential damages The Seller's sole liability shall be repair, replacement, or return of purchase price at our option. Warranty returns first must be authorized by the factory, and repairs or replacements (at our option) will be made without charge for instruments returned freight prepaid to the factory or authorized repair depot when our examination satisfactorily indicates that defects are due to workmanship or materials. Electron tubes, batteries, fuses, lamps and transistors are excluded from Warranty coverage. If the instrument or any portion thereof, has been abused, misused, damaged by accident or negligence, or if any serial number or seal has been removed or altered, this warranty is VOID.

This warranty is expressly in lieu of any other warranties expressed or implied, including any implied warranty of merchantability, or fitness for a particular purpose, any other obligations or liability on the part of The Singer Company, and it neither assumes nor authorizes any other person to assume for it any other liability in connection with the sale of instruments manufactured by it.

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REPAIR AND MAINTENANCE

Instruments should be returned only on prior written authorization from the Singer Representative or the factory(1). Please provide the following information in order to expedite our processing of your instrument:

1. Model or Type
2. Serial Number
3. Approximate date instrument was placed in operation
4. Approximate number of hours of use
5. Description of trouble(2)
6. Has maintenance action been previously requested?
7. Other comments

Upon receipt of this information our Service Department will send you service data or shipping instructions. Upon receipt of shipping instructions forward the instrument prepaid to the specified center or factory. If requested, an estimate of charges will be made before work begins.

(1) West Coast Service Center, 3211 S. LaCienega Blvd., Los Angeles, California 90016, Telephone (213) 870-2761, TWX 910-340-6352 for all Singer Instrumentation equipment; or Palo Alto Operation, 3176 Porter Drive, Palo Alto, California 94304, Telephone (415) 493-3231 TWX 910-373-1765 for Palo Alto Operation instruments.

(2) Include data on symptoms, measurements taken, test instruments used, suspected location of trouble, maintenance action taken, and any other relevant data.

MANUAL CHANGES

FOR

MICROWAVE AMPLIFIER

5000 Series

Make corrections to errata listed below and make applicable changes(s) listed in the table below according to instrument serial number.

SERIAL NO.	MAKE CHANGES
287 & above	1
As indicated	1,2
370 & above	1,2,3
342 & above	1 thru 4

SERIAL NO.	MAKE CHANGES
371 & above	1 thru 5
11 & above	6

ERRATA: Parts List, page 6-1: Add the K4 listing: Alternate is part no. 106-52 with bracket part no. 901576 (bracket for 106-23 version is 901221).

CHANGE 1: In the parts list, page 6-3, and schematic 900913, change A2R14 to 3.3K, part no. 51-3.3K, mfr.part no. E-009-AB/B-3.3K.
In the parts list, page 6-2, and schematic 900842, add note to indicate that V4 is not used with Model 5030 and Model 5040 Amplifiers.
In the parts list, page 6-1, change Chassis Part, C12, part no. to 952124, mfr: 03782, 952124.

CHANGE 2: In Section 4, delete paragraph 4.7.3.
On Schematic 900914, delete CR1.

Effective Serial No's are:
5010 - 298 & up
5020 - 293 & up
5030 - 285 & up
5040 - 301 & up

CHANGE 3: Change all references to Model 5000 Series 10-Watt Amplifier to read: Model 5000 Series 10- and 20- Watt Amplifiers.
Table 1-1, Specifications:
Add the following listings for 20-watt amplifiers:
Model 5110, 1 to 2 GHz
Model 5120, 2 to 4 GHz
Model 5130, 4 to 8 GHz
Model 5140, 8 to 12.4 GHz
Para. 2.2., Add F1 listing for 20 watt amplifiers: 6 amp, Part No. 121-28.

Parts List: Change the T1 listing as follows:
T1, Transformer Part No. 91-214 Mfr: 03782, 91-214, (91-203 is alternate for 10 w Amplifier only).
Add the following V-TWT listings:
For Model 5110 (1-2 GHz), Part No. 112-120, Mfr: 03782, 112-120.
For Model 5120 (2-4 GHz), Part No. 112-128, Mfr: 03782, 112-128.
For Model 5130 (4-8 GHz), Part No. 112-127, Mfr: 03782, 112-127.
For Model 5140 (8-12.4 GHz), Part No. 112-132, Mfr: 03782, 112-132.
Change A6 listing for Model 5020 to read 5020/5120.
Change A6 listing for Model 5010 to read 5010/5110.
Change A6 listing for Model 5030 to 5030/5130 and A6 listing for 5040 to 5040/5140 with following differences:

June 20, 1972

5130 A6 Assy. No. is 952158
5140 A6 Assy. No. is 952159
A6R1, R2 are MTL FLM Resistors 383K, 1 w, 1%, Part No. 52-383K, Mfr: 19701, MFS-1-T2-383K.
A6R3-7 are MTL FLM Resistors, 464K, 1w, 1%, Part No. 52-464K, Mfr: 19701, MFS-1-T2-464K
Add F1 listing for 20 watt amplifiers as follows:
Type 3 AG, slo-blo, 6 amp, 125V, part no. 121-128, Mfr: 75915, 312006.
Schematic 900914 and Parts List:
Change A6R17 to A6R18 (excluding listing for Model 5030 and 5040 which remains A6R17). Replace A6R15, R16 with short.

CHANGE 4: Schematic 900911 and Parts List, page 6-4:
Add Diode A4CR5, 1N459, Part No. 81-41, between A4Q9 collector and resistor A4R4. Anode of A4CR5 should be connected to collector of A4Q9.

Change nominal value of A4R17 from 12K ohm to 10K ohm, Part No. 51-10K.

CHANGE 5: On schematic 900842 and parts list, page 6-1; delete Capacitor C12, .01 μF, 3k V.

CHANGE 6: Change Paragraph 3.2, step c. to read ".....approximately 60 seconds."
Change Parts List to read: K1, Alfred Part No. 106-25, time delay, 60 sec., True Mfg. Part No. 6N060T.

SUBSTITUTE: New Tube Warranty and Replacement Procedures (attached) for those in the back of this manual.

CHANGE 7: Add the following V-TWT listings:
For Model 5010-1 (1.4 to 2.5 GHz), Part No. 112-084, Mfr: 03782, 112-084.
For Model 5030-1 (3.7 to 6.5 GHz), Part No. 112-134, Mfr: 03782, 112-134.
For Model 5041 (7 to 12.4 GHz), Part No. 112-133, Mfr: 03782, 112-133.
For Model 5053 (12.4 to 18 GHz), Part No. 112-131, Mfr: 03782, 112-131.

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SECTION 1

GENERAL INFORMATION

1.1 THE ALFRED MODEL 5000 SERIES MICROWAVE AMPLIFIER.

Each ALFRED Model 5000 Series Microwave Amplifier provides 10 watts rated output in its operating frequency band, and consists of a packaged traveling-wave tube (TWT) and all associated power supplies and protection circuits. Individual model numbers and operating frequency bands are tabulated in Table 1-1.

The Model 5000 Series Microwave Amplifiers utilize advanced PPM-focused TWT's and provide at least 30 db gain from low levels to rated power output. Unique protection circuits protect the TWT against damage from either improper turn-on of high voltage power or malfunction of any power supply or the cooling fan.

Specifications of the Model 5000 Series Microwave Amplifiers are given in Table 1-1. An installation drawing providing dimensional data is included as Figure 1-1. The rf input and output connectors of the TWT serve as the input and output connectors of the amplifier, to eliminate insertion effects of other components. These connectors are normally located on the front panel with the pushbutton-type operator controls. As Option 1, the rf connectors are located on the rear panel. The forced air cooling system air intake grille and filter are located on the same panel as the rf connectors.

1.2 SCOPE OF THIS MANUAL.

This Instruction Manual covers detailed descriptive data, operating instructions, circuit theory, and servicing information for the Model 5000 Series Microwave Amplifiers.

1.3 APPLICATIONS OF THE MODEL 5000 SERIES AMPLIFIERS.

The Model 5000 Series Microwave Amplifiers may be used to amplify the output from all types of microwave signal sources, such as mechanically tuned signal generators, unit oscillators, and sweep oscillators such as the ALFRED Model 650 Series and Model 6400 Series. Leveled output can be obtained by including the Model 5000 Series amplifier in the external leveling loop of the signal source.

The Model 5000 Series is designed to provide reliable service in demanding environments. Adequate shielding is provided to minimize rf radiation. The instruments can be used in virtually any field or laboratory application requiring a 10-watt microwave amplifier with a fixed gain of 30 db or more. The Model 5000 Series amplifiers are also ideal for ultrareliable service in unattended locations, because the "total protection" circuits prevent tube damage in unattended operation. In such installations, a second unit may be operated in standby mode with a remote-controlled power-level sensing circuit used to switch between units. Switching times in the order of milliseconds are possible to assure continuous service.

SAFETY PRECAUTIONS

Voltages of up to -3500 V are present inside the chassis of this instrument. Before removing the top or bottom covers, read the CAUTION note on page 5-1 of this manual.

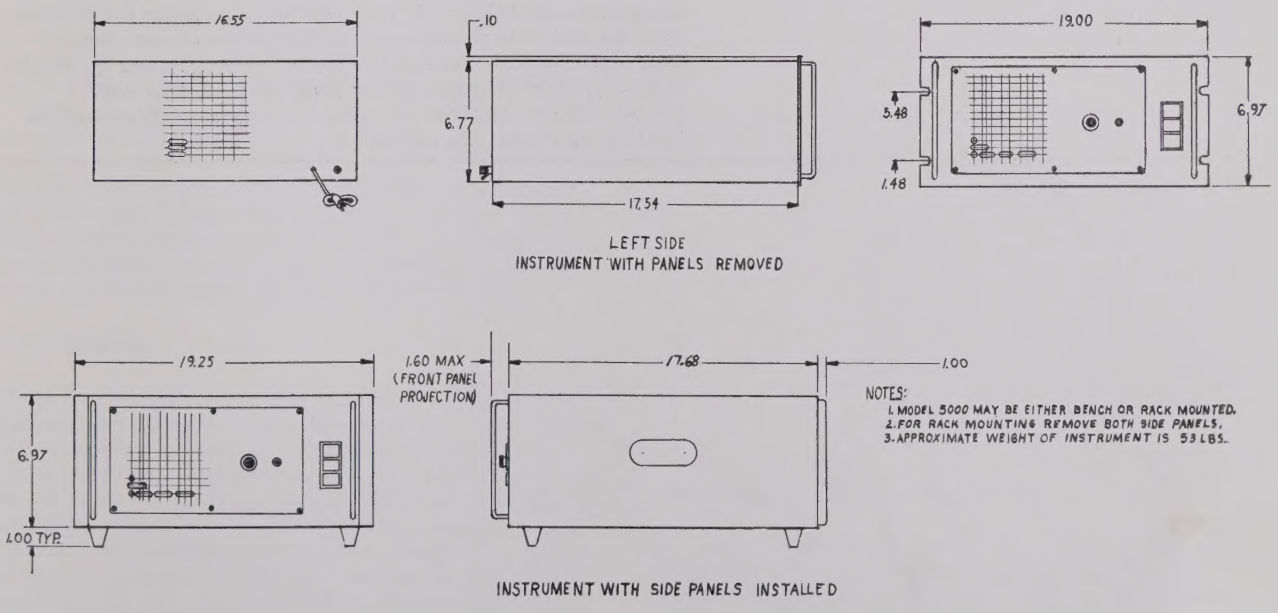


FIGURE 1-1. OUTLINE OF MODEL 5000 SERIES.

Table 1-1. Specifications of the Model 5000 Series Microwave Amplifiers.

Frequency Range (GHz):	
Model 5010	1 to 2
Model 5020	2 to 4
Model 5030	4 to 8
Model 5040	7 to 11*
Rated Power Output (watts, when operating with a load having a VSWR < 1.5:1):	10
Maximum load mismatch for no tube damage:	3.0:1
Maximum load mismatch for rated power:	1.5:1
Gain at 10 watts output (db):	30
Small-Signal Gain (db):	30
RF OUT stability:	Open- and short-circuit stable with no drive; must not be left without proper load when drive signal is applied.
Spurious Modulation, non-harmonic:	35 db below signal level
Noise Figure, max (db):	35
RF Impedance (ohms):	50
RF Connectors:	Type N female
Controls:	On-off/standby/operate provided by lighted pushbuttons.
Input Voltage:	105 to 125 V or 210 to 250 V, 50/60 Hz. 400 Hz operation available on special order as Option 2. Approximately 570 voltamperes.
Physical:	Cabinet-mounted with metal dust covers. Sides with recessed handles may be removed to permit 19" rack installation for system applications. Air intake and filter on same panel as rf input/output connectors (front panel standard, rear panel on special order as Option 1). Height 7" (panel), width 19", depth behind panel 18-1/4", total depth 19-1/4". Weight, less than 60 pounds. Light gray panel, contrasting dark blue-gray sides, top, and bottom.

* 2 watts, 11 to 12.4 GHz.

SECTION 2

INITIAL INSTRUCTIONS

2.1 RECEIVING INSPECTION.

Upon receiving your Model 5000 Series Microwave Amplifier, carefully unpack the instrument and check for shipment damage. If some damage is evident, file a claim against the carrier. Refer to the Shipment Damage Claim form in the back of this manual.

2.2 POWER REQUIREMENTS.

The unit is normally connected at the factory for operation at 105 to 125 V ac (115 V ac nominal) and 50 to 60 Hz. However, provisions are provided for easy conversion to operation at 210 to 250 V ac (230 V ac nominal). With the top cover removed, locate the power switch labeled 115 VAC (Figure 5-1). Remove the plate and move the switch level to its alternate position. Turn the plate over and replace it with 230 VAC showing. To reconvert for 115 V ac operation, reverse the above procedure. Instruments utilizing a 400 Hz blower and designed to operate on 400 Hz power rather than 50 - 60 Hz power are designated as Option 2.

CAUTION

When changing operating voltage, be sure to change the line fuse F1 to provide proper protection. The fuse value should be as tabulated below:

FUSE F1 VALUE (All Slo Blo)

MODEL	115 V	230 V
5010	4 AMP	2 AMP
5020	4 AMP	2 AMP
5030	4 AMP	2 AMP
5040	5 AMP	2.5 AMP

2.3 CHASSIS GROUNDING.

The instrument is supplied with a three-conductor power cord and a three-prong plug, which grounds the instrument when plugged into an appropriate receptacle. If a three-prong to two-prong adapter is used, make sure the unit is properly connected to ground by grounding the adapter pigtail lead.

2.4 COOLING.

Adequate space must be provided at the front and rear of the instrument for cooling purposes. This instrument utilizes forced air cooling which is ducted from the air intake grille located next to the rf output connector (normally on the front panel; on the rear panel in Option 1). The air outlet is normally on the rear panel. (With Option 1, it is on the front panel.) The air intake and outlet openings should not be obstructed. If the instrument is rack-mounted, adequate provision for exhausting heated air from the outlet opening should be provided. Since forced-air cooling is used no ventilation space on the top, bottom, or sides is required.

2.5 INCOMING INSPECTION TEST.

CAUTION

Refer to Section 5 of this manual before touching any internal adjustments.

The following inspection test may be performed prior to regular operation of the Model 5000 Series amplifier.

2.5.1 POWER OUTPUT AND FUNCTIONAL PERFORMANCE CHECK. Proceed as follows:

a. Obtain a signal generator which can be adjusted to cover the same frequency band as the Model 5000 Series Amplifier being tested, which is specified in Table 1-1. A suitable instrument would be an ALFRED Sweep Oscillator which can be swept across the operating band of the amplifier.

b. Connect to the signal generator rf output connector a flat attenuator which, in conjunction with any power level control provided in the signal generator, will permit output power to be held to less than +10 dbm across the band.

c. Connect to the Signal Generator rf output line, in series with the attenuator (if used), an ALFRED Model 1403 or 1404 crystal detector which has been calibrated for direct reading power measurement on the ALFRED Model 8000/7051 or 8000/7052 Sweep Analyzer.

NOTE: If an ALFRED Sweep Analyzer is not available, use any conventional power meter which can measure power levels up to +10 dbm.

d. While monitoring the signal generator rf output, verify and/or adjust it so that the level does not exceed +10 dbm across the full swept band.

NOTE: If an ALFRED Model 8000/7051 Sweep Network Analyzer is not available and power output from the rf signal generator is not leveled, make a plot of signal generator output power across the band for later use in comparison with the amplifier output. The Model 8000/7051 will permit simultaneous comparison and eliminate need for a plot of the input power.

e. Disconnect the crystal detector or power meter sensor from the signal generator rf output line.

f. Connect to the amplifier RF OUT connector a flat 30 db attenuator, and connect to the attenuator output the ALFRED Model 1403 or 1404 Crystal Detector used with the ALFRED 8000/7051 or 8000/7052 for power measurements in step d.

NOTE: If an ALFRED Sweep Analyzer is not available, use an attenuator having an attenuation sufficient to reduce output power to within the operating range of the power meter sensor used. The output power from the amplifier may be as high as +45 dbm.

g. Without changing the signal generator control settings or removing the attenuator used in the power check of step d, connect this rf signal line to the RF IN connector of the Model 5000 Series Amplifier.

h. Press the POWER pushbutton on the front panel of the Model 5000 Series Amplifier so that it lights to indicate power ON.

i. After a warmup period of about 90 seconds, the STANDBY pushbutton should light, indicating that the instrument has automatically entered the Standby Mode. At that time press the OPERATE pushbutton, which should light to indicate that RF output is ON.

j. Monitor the power output across the full operating band of the amplifier. With an input level of about +10 dbm, the output level should exceed +40 dbm across the band.

2.5.2 AMPLIFICATION CHECK. Proceed as follows:

a. If an ALFRED Model 8000/7051 Sweep Network was used for measuring absolute power output in the preceding test, it is simple to measure amplification of the Model 5000 Series Amplifier in terms of insertion gain. To do this sample the input power to the amplifier by means of a flat 20 db directional coupler and compare the dual channel power output and power input displays or operate the instrument in the ratio mode and read the insertion gain directly. Gain should exceed 30 db across the full operating band.

b. If a conventional power meter is used for the output power measurement in paragraph 2.5.1 above, plot the output power and compare with the input power to obtain a direct indication of gain across the band. The gain should be greater than 30 db across the band.

2.5.3 SMALL-SIGNAL GAIN CHECK. Proceed as follows:

a. Adjust the rf signal generator and/or increase the amount of attenuation in the signal generator output line so that the incident power level applied to the amplifier RF IN connector is ≈ -20 dbm.

b. Make a power output/power input ratio measurement using the ALFRED 8000/7051 Sweep Network Analyzer, if available, to directly measure small-signal gain performance. The gain across the full frequency band of operation should be greater than 30 db.

c. If a Model 8000/7051 is not available, make power input and power output measurements, as necessary, following the procedure of paragraph 2.5.1 and 2.5.2 above, to evaluate the amplifier gain. The gain should exceed 30 db across the full operating frequency band.

2.6 RETURNING THE INSTRUMENT.

If it becomes necessary to return the instrument to ALFRED ELECTRONICS, authorization must first be obtained from our Sales Department. When authorization is received, prepare the instrument for shipment by wrapping it in a protective material such as polyethylene and heavy wrapping paper to protect against marring by the padding used in the container. A sufficient quantity of padding material, such as hairflex, should be placed all around the instrument for cushioning. If the original shipping container is not available, an equivalent rugged cardboard container or wooden crate should be used for the packing carton. Pack the instrument so that it cannot move around in the container. A letter containing all pertinent information should be included in the package unless such a letter has previously been sent to our Sales Department.

SECTION 3

OPERATION

3.1 FRONT PANEL CONTROLS AND CONNECTORS.

A functional description of all front panel controls is given in Table 3-1.

3.2 INSTRUMENT TURN-ON PROCEDURE.

a. Check that the line cord is plugged in and properly grounded.

b. Press the POWER pushbutton. This button should glow to indicate that power is applied.

c. After a warmup period of about 90 seconds, the STANDBY pushbutton should glow to indicate that the instrument has entered the Standby Mode.

d. Connect the desired load to the RF OUT connector.

CAUTION

Loads having a VSWR greater than 3:1 should not be connected to the instrument. Loads having VSWR greater than 1.5:1 may prevent the instrument from providing the full 10 watt output power level.

e. Connect the desired drive signal to the RF IN connector.

f. Press the OPERATE pushbutton which should glow to indicate that the instrument has entered the Operate Mode and is providing amplification.

g. If it is desired to change the signal connections or turn off the amplifier output temporarily, press the STANDBY pushbutton to switch the instrument to Standby Mode. The OPERATE pushbutton can be pressed at any time to restore the instrument to Operate Mode.

CAUTION

Never place the instrument in Operate Mode when an input drive signal is connected to the RF IN connector unless a suitable load is connected to the RF OUT connector. Reflections of amplified power from the unterminated RF OUT connector can damage the traveling-wave tube.

3.3 INSTRUMENT TURN-OFF PROCEDURE.

To turn the instrument off from either the Operate Mode or the Standby Mode, simply press the POWER pushbutton.

NOTE

If it is desired to temporarily eliminate the RF OUTPUT without having to wait for the 90-second warmup interval when output is next desired, press the STANDBY button instead, to place the instrument in Standby Mode. This will allow immediate restoration of the Operate Mode when desired.

3.4 PROTECTION CIRCUIT FUNCTIONING.

3.4.1 GENERAL. Unique protection circuits are provided to protect the traveling-wave tube and the power supplies from damage. A special high-speed vacuum relay provides extremely rapid turn-on and turn-off of the high voltage power supplied to the TWT cathode and other electrodes. This prevents defocusing of the tube by improper application or removal of high voltage, and assures realisticly fast turn-off for protection against improper operating conditions. The protection circuits remove high voltage by automatically switching the instrument out of the Operate Mode instantly, if any of the following conditions appear:

(1) Helix overcurrent

(2) TWT heater overcurrent or overvoltage

(3) TWT heater undervoltage

(4) Insufficient air flow around the traveling-wave tube surface

(5) Any printed circuit board missing or incorrectly inserted

(6) Top or bottom cover plates loose or removed

In addition, turn-on to the Operate Mode is prevented if any of these conditions exist.

3.4.2 IDENTIFICATION OF CONDITIONS CAUSING SHUTDOWN. The occurrence of conditions (1), (2), and (3) listed above will cause the instrument to switch from Operate Mode to Standby Mode automatically; initial presence of these conditions will prevent the instrument from being switched from Standby Mode to Operate Mode. The occurrence of conditions (4), (5), or (6) will cause the instrument to switch from Operate Mode to Power On Mode; initial presence of these conditions will prevent the instrument from switching to Standby Mode from Power On Mode after the 90 second delay interval. Thus, if the instrument does not automatically enter the proper mode after turn-on, check for the existence of one or more of the above conditions. If the instrument automatically switches out of the Operate Mode to either the Standby Mode or the Power On Mode at any time during operation, the cause is due to the appearance of one of the above conditions which should be remedied.

Table 3-1. Description of Front Panel Controls and Connectors.

CONTROL OR CONNECTOR	FUNCTION
POWER ON-OFF Pushbutton	A push-on, push-off type control which alternately turns on primary power and removes all power from the instrument. When primary power is applied, the button glows to indicate this condition. Once this button is pressed to turn power on, the instrument will automatically cycle into the Standby Mode after a delay period of about 90 seconds, at which time the STANDBY button will automatically become lighted. The POWER button may be pressed at any time to turn all power off.
STANDBY (HV ON) Pushbutton	The instrument automatically enters the STANDBY mode approximately 90 seconds after the power has been turned on by pressing the POWER button. The STANDBY button glows to indicate that the instrument has entered the Standby Mode. After the instrument has been placed in the Operate Mode by pressing the OPERATE pushbutton, it can be returned to the Standby Mode whenever desired by pressing the STANDBY button. CAUTION The instrument should not be allowed to function in the OPERATE mode for any length of time with a drive signal connected to the RF IN connector if no load is connected to the RF OUT connector. If no input signal is applied to the RF IN connector, the instrument can be left in the Operate Mode regardless of whether a load is connected to the RF OUT connector. When the instrument has been in OPERATE mode and it is desired to not turn power off when the input signal remains while the load is removed from the RF OUT connector, press the STANDBY button to return the instrument to the STANDBY mode. The amplifier is then ready for instant operation whenever desired by switching to OPERATE mode.
OPERATE (RF ON) Pushbutton	When the instrument is in Standby Mode, the OPERATE button may be pressed to switch the instrument to Operate Mode to provide amplified rf output. The button glows to indicate that the instrument is in the Operate Mode. When the instrument is in Operate Mode, it can be switched to either Standby or Off Mode by pressing the appropriate button. It is not necessary to press the STANDBY button before pressing the POWER button to turn the instrument off from Operate Mode if complete turn-off is desired.
RF IN Type N Connector	This connector receives the input RF signal to be amplified. Any signal level up to +10 dbm may be applied. Signal levels above +10 dbm will cause amplifier output to exceed the specified 10-watt output level and may cause either peak-clipping or overdriving. The helix overcurrent sensor will protect the tube from damage if an overdriven condition exists. CAUTION If a drive signal is connected to the RF IN connector before a suitable load is connected to the RF OUT connector, the instrument must not be placed in Operate Mode until the load is connected.
RF OUT Type N Connector	This connector provides the amplified rf output signal from the instrument. The output signal level will be amplified so that it is at least 30 db above the input signal level or > 10 watts, whichever is less. CAUTION Load VSWR greater than 3:1 may damage the traveling-wave tube contained in the amplifier. Never connect a mismatched load to the rf output connector which would produce a VSWR greater than 3:1. Never operate the instrument in the OPERATE mode with no load connected to the RF OUT connector if a signal is applied to the RF IN connector. Load VSWR greater than 1.5:1 may prevent obtainment of rated power output.

3.4.3 RESTORATION OF OUTPUT AFTER SHUT-DOWN. When the instrument is turned on after the trouble has been remedied, there will be a 90-second delay period after which time the instrument will automatically enter the Standby Mode. The OPERATE button can then be pressed to re-establish the Operate Mode.

3.5 FIELD AND LABORATORY APPLICATIONS.

The Model 5000 Series Microwave Amplifiers are designed to provide reliable service in demanding environments. These instruments may be used to amplify the output from all types of microwave signal sources such as mechanically tuned signal generators, unit oscillators and ALFRED sweep oscillators. Gain and phase stability is provided through the use of well regulated low ripple dc supplies for every traveling-wave tube electrode and filament. Adequate shielding is provided to minimize rf radiation.

3.6 APPLICATIONS IN UNATTENDED LOCATIONS.

The effective protection circuits included in the Model 5000 Series Microwave Amplifier prevent tube damage in unattended operation. This, plus the fact that these amplifiers can be turned on and off by a simple remote control circuit (see Figure 4-5), makes these units ideal for unattended remote locations where maximum reliability is required. By operating a backup unit in Standby Mode with a remote controlled power level sensing circuit used to switch between units, continued service is assured with a total switching time between units of just a few milliseconds. These amplifiers are thus well suited for remote microwave links and CATV installations.

3.7 POWER OUTPUT LEVELING. (See Figure 3-1.)

Leveled output can be obtained by including the 5000 Series Amplifier in the external leveling loop of the signal source. An external sampling coupler should be used having a coupling coefficient of 30 to 40 db to reduce the signal level to a safe value for the sampling crystal detector.

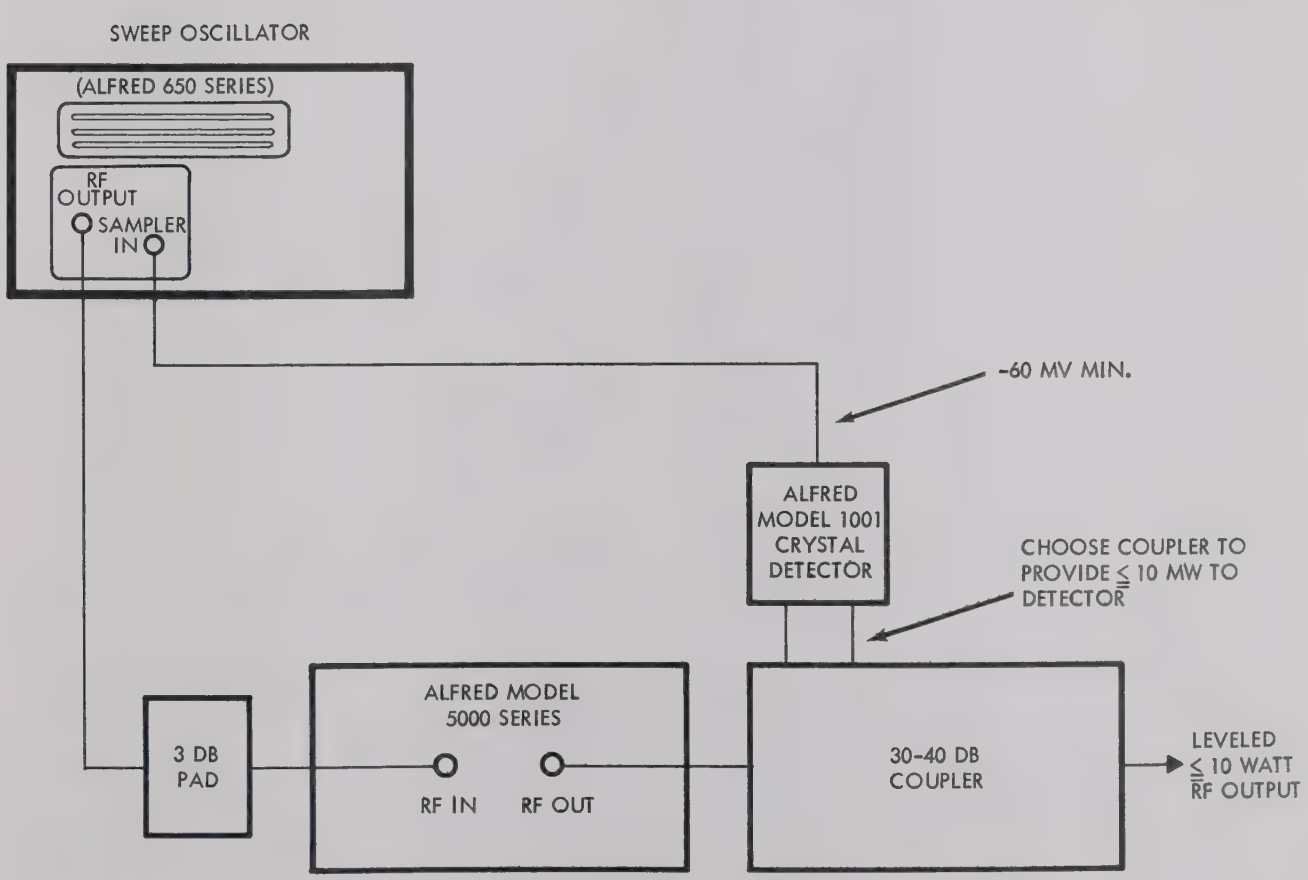


FIGURE 3-1. CONNECTIONS FOR POWER OUTPUT LEVELING.

SECTION 4

CIRCUIT DESCRIPTION

4.1 BLOCK DIAGRAM DESCRIPTION (See Figure 4-1.)

4.1.1 GENERAL. The Model 5000 consists of a main chassis with four major P.C. Boards, and a Traveling Wave Tube having a maximum output of 10 watts rf power (+ 40 dbm). The main function of the instrument circuits is to supply suitable operating voltages and malfunction protection for the costly Traveling Wave Tube (TWT or TW tube). The P.C. Boards and their functions are tabulated in Table 4-1 for reference in conjunction with the block diagram description and Figure 4-1.

4.1.2 POWER SUPPLY CIRCUITS. The TWT used in the Model 5000 Series operates with the helix at ground or near-ground potential, and with the cathode at a negative voltage between 1100 and 3000 volts, depending upon frequency range. The collector is operated at ground potential. The anode is operated at a voltage positive with respect to the cathode, and is powered by a bleeder to ground from the cathode supply. The functional interconnection of these supplies and the TWT is illustrated in Figure 4-1.

The -40 volt DC regulated supply is the primary zener-controlled instrument reference. It and the + 20 volt DC regulated supply provide operating power for the solid state heater and high voltage supply regulator and protection circuits. For tubes not having a capsule-grounded helix, the + 20 volt supply also provides operating power to the TWT helix. The + 20 volt supply is connected to the helix through the overcurrent sensor dropping circuit, so that the helix itself is essentially at ground potential.

The 12 volt DC supply is unregulated and provides operating power for relays K3 and K4 in the protection circuits. The + 90 volt DC supply is unregulated and provides operating power for the screen grids of the high voltage regulator tubes. The 6.3 volt ac supply provides power for the regulator tube heaters and the standby mode protection circuit loop which includes relays K1 and K2.

The cathode supply develops the high negative voltage for the TWT cathode, which is connected directly to the (-) supply output through the contacts of protection relay K4. Cathode supply voltage is regulated by a closed-loop feedback circuit controlling the regulator tubes that establish a variable drop between the supply (+) output and ground.

The TWT heater supply (-) output is connected to the common cathode/heater (+) terminal of the TWT. The heater supply develops 6.3 volts DC which is regulated by a feedback circuit which includes malfunction-sensing protection circuit stages

NOTE: On units having Serial No. 251 and below, the heater supply (-) terminal is common-connected to the TWT cathode at TB1-3 and the heater supply (+) output is connected as a separate lead at TB1-1. On units having Serial No. 252 and above, the heater supply (+) terminal is common-connected to the TWT cathode at TB1-3, and the heater supply (-) terminal is connected as a separate lead at TB1-2. This latter configuration is described and illustrated in this manual unless otherwise noted.

4.2 REGULATED LOW VOLTAGE SUPPLIES. (See Figure 4.2 and Schematic 900912).

The regulator circuits contained on P.C. Board A1 provide - 40 V DC (A1Q1, A1Q2, A1Q8, and A1Q9) and + 20 V DC (A1Q3 - A1Q7). The zener-regulated - 40 V supply is the primary reference for the other supply circuits in the instrument.

4.2.1 -40 V SUPPLY. The rectifier circuit for the - 40 V supply consists of full-wave rectifier A5CR9 - A5CR12 and filter C9. The output of this rectifier is ≈42 V. Neither polarity of the rectified output is directly connected to ground. Instead, both terminals are connected to the regulator circuit on A1, (+) to A1-S and (-) to A1-J. The - 40 V regulator circuit provides a controlled voltage drop between the rectifier (+) terminal (A1-S) and ground, through A1R3 and A1Q2, to maintain exactly - 40 V (with respect to ground) at A1-J. For example, if the raw rectifier output is + 42 V, a 2 V drop is established between A1-S and ground (A1-L), so that the (-) output at A1-J is exactly - 40 V with respect to ground. The regulator circuit includes differential amplifier A1Q8/A1Q9, zener reference diode A1CR4, regulator driver A1Q1, and regulator A1Q2. The regulator feedback loop operates as follows to keep the output constant at - 40 V:
If the - 40 V tends to increase to a greater negative voltage, the forward base-emitter bias applied to A1Q8 is decreased, causing A1Q8 to decrease conduction to less than that of A1Q9, the base of which is zener-referenced to ground. The resultant increased conduction of A1Q9 causes an increased voltage drop across A1R15, which connects the base of A1Q1 to + 20 V. This drops the base voltage of A1Q1, causing it to reduce conduction. Since A1Q1 connects the base of regulator transistor A1Q2 to + 20 V, reducing the A1Q1 conduction decreases the forward bias of A1Q2, thereby increasing the voltage drop across it between the (+) terminal of the supply (A1-S) and ground, to offset the tendency of the supply output to increase, and maintain the regulated - 40 V output (A1-J) at - 40 V with respect to ground. If the -40 V output tends to drop to a lesser negative voltage, the regulator loop acts in an opposite manner to increase the conduction of A1Q2.

4.2.2 + 20 V SUPPLY. The rectifier circuit for the + 20 V supply consists of full-wave recifier A5CR5 - A5CR8 and filter C8. The output of this rectifier is ≈ 21 V. The (-) output terminal is connected to ground, and the unregulated (+) output terminal connects to A1-A. The + 20 V regulator circuit provides a controlled voltage drop between the rectifier + terminal and the regulated + 20 V output terminal (A1-B) so that the + output at A1-B is exactly + 20 V with respect to ground.

The + 20 V DC regulator circuit includes differential amplifier A1Q6/A1Q7, regulator driver A1Q4, constant current source A1Q3, and emitter follower series regulator A1Q5. The regulator feedback loop operates as follows to keep the output constant at + 20 V:

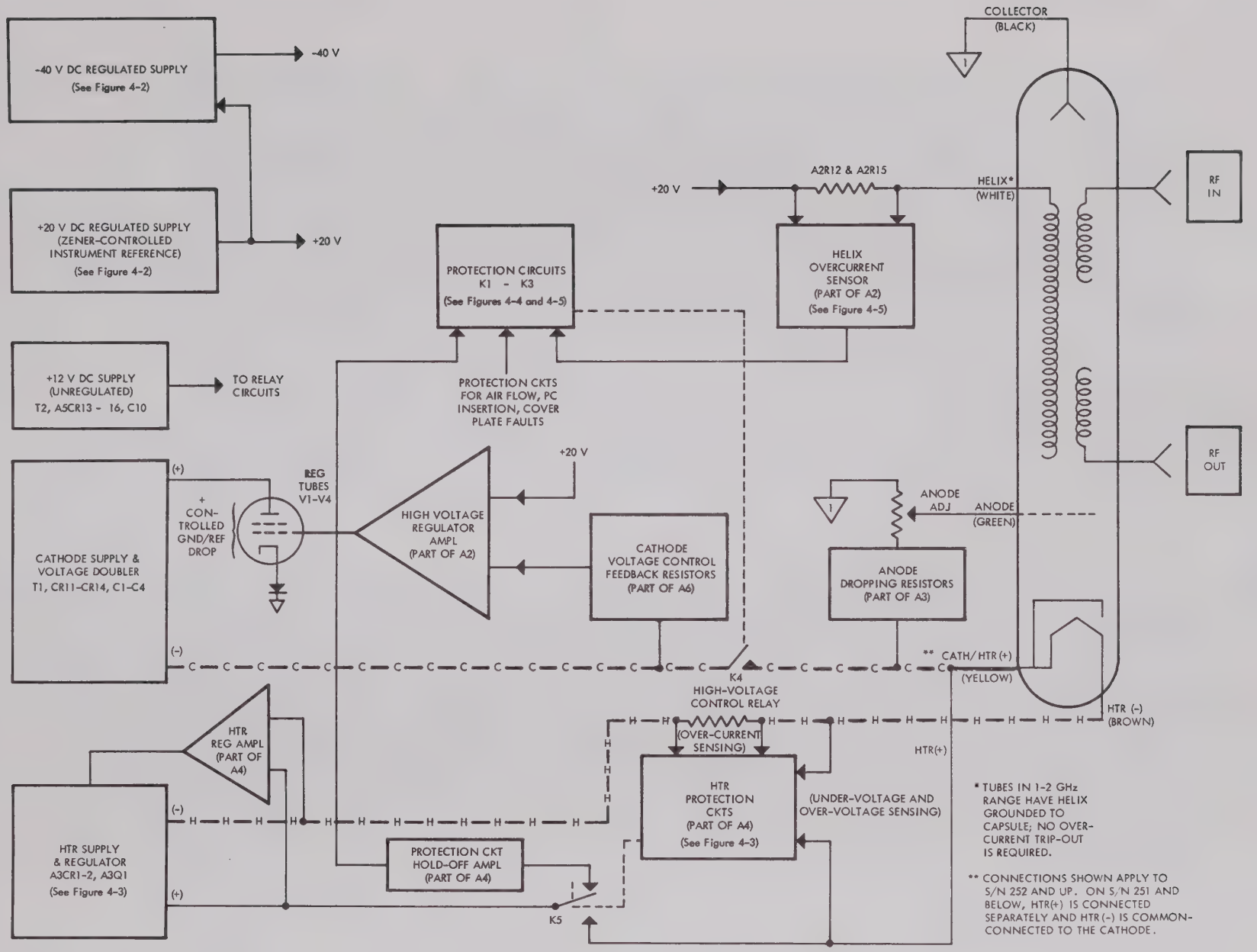


FIGURE 4-1. BLOCK DIAGRAM OF MODEL 5000.

TABLE 4-1. CIRCUIT BOARDS IN THE MODEL 5000 SERIES

REF DESIGNATOR & PART NO.	NAME	LOCATION	FUNCTION
A1 (951005)	Low Voltage Regulator PC Board	Top, left-hand part of chassis at the center.	Contains the regulator transistors and the regulator feedback amplifiers for the - 40 V and + 20 V regulated dc supplies.
A2 (951014)	High Voltage Regulator/ Protection Circuit PC Board	Top, left-hand part of chassis at the center.	Contains the regulator sensor/amplifier circuits which control the high voltage regulator tubes for the cathode supply. Also contains the high voltage protection circuits that respond to a TWT heater supply or helix current malfunction and energize K3 to cut off high voltage.
A3 (951007)	Heater Supply Platform Assy.	Mounted horizontally in the right-hand part of the chassis, above an opening in the center deck.	Mounts the PC connector for the heater regulator/protection circuit PC board A4 and contains other heater supply components which are not contained on PC board A4, including the rectifier diodes, regulator transistor, protection circuit photosensitive resistor, and heater supply relay K5.
A4 (951006)	Heater Regulator/ Protection Circuit PC Board	Top, right-hand part of chassis at the center (plugs into A3).	Contains the regulator sensor/amplifier circuits which control the heater supply regulator transistor A3Q1. Also contains the sensor/amplifier circuits which protect against over-voltage, under-voltage, and overcurrent conditions.
A5 (951015)	Low Voltage Rectifier Assy.	Bottom, left-hand part of chassis near the rear.	Contains the rectifier diodes for the + 20 V and - 40 V dc supplies, the + 12 V relay supply, and the + 90 V regulator tube screen supply.
A6 (See pg. 6-1 for Part No.)	High Voltage Bias PC Board	Top, right-hand part of chassis at the center (plugs into A3).	Contains feedback dropping resistors for the cathode supply and voltage divider dropping resistors which enable the anode supply voltage to be developed from the cathode supply output. A different board is used for each Model, to provide the different cathode feedback and anode voltages required for that Model's TWT.

The instantaneous output level is compared to the zener-regulated - 40 V supply through voltage divider A1R16/A1R17, which drives the base of A1Q7. When the output is properly at + 20 V, it and the - 40 V supply output divide across A1R16/R17 to provide approximately 0 V at the base of A1Q7. If the supply output tends to rise above + 20 V, the base of A1Q7 is driven positive. This causes A1Q7 to conduct more heavily, and since constant current is supplied by A1Q3, the result is that A1Q7 robs current from the base of A1Q4, decreasing the forward bias of A1Q4. The decreased conduction of A1Q4 reduces the forward base bias on regulator A1Q5, to decrease its conduction and provide a greater drop across it to restore the output to + 20 V. If the output tends to drop below + 20 V, A1Q7 decreases its conduction, and more of the constant-current drive is available to the base of A1Q4. The resulting increase in conduction of A1Q4 provides increased forward bias to regulator transistor A1Q5 to reduce its series drop and raise the output level to + 20 V.

4.2.3 SURGE PROTECTION FOR - 40 V AND + 20 V SUPPLIES To provide protection against any voltage surge which might occur at the turnoff of power, diodes A1CR1 and A1CR2 and connected between the + terminal of the output filter sections of the capacitors C8 and C9 and the remaining circuit components. At turnoff, these diodes provide protection in case the unregulated output collapses faster than the decay of voltage from these filter capacitors, to prevent an output surge when the regulator transistors become inoperative. A1R8 provides for calibration and adjustment of the - 40 v supply. The +20 V supply receives its reference from the - 40 v supply through 1% resistor A1R10, and does not have a separate adjustment.

4.3 UNREGULATED DC SUPPLIES (See Schematic D900842).

4.3.1 UNREGULATED + 12 V DC SUPPLY. This supply consists of A5CR13 - A5CR16 and C10 on the main chassis. It is driven by the 10 Vac output developed between T2-5 and T2-6. It provides full wave rectification with filtered output to drive the high voltage protection circuit relays K3 and K4. Instruments S/N 31 & below use 26 V relays K3 and K4 and utilize a transformer T2 having 40 V output between terminals 5-6.

4.3.2 UNREGULATED + 90 V DC SUPPLY (See Schematics D900842 and C900913). This supply consists of A5CR1 - A5CR4 and C6 on the main chassis. It provides full wave rectification with filtered output to supply the screeen grids of the cathode supply regulator tubes V1 - V4. The supply output, at the + terminal of C6A, may range from 90 - 120 V DC. It is connected to J4-A and through a 57K ohm resistor dropping network to ground at J4-C. The screen drive voltage is tapped at the junction of A2R1 and A2R2 and applied to the V1-V4 screens via J4-B and the individual screen load resistors R23 - R26. This voltage, which range from ≈+ 85 V to + 112 V, is further filtered by C6B.

4.4 TWT HEATER VOLTAGE REGULATED SUPPLY AND PROTECTION CIRCUITS. (See Figure 4-3 and Schematic C900911).

4.4.1 HEATER SUPPLY AND REGULATOR CIRCUITS. The heater supply consists of dual rectifiers A3CR1 and A3CR2 which form a full-wave rectifier bridge, filter capacitor A3CR7 A3CR7, regulator transistor A3Q1, and the regulator sensor, amplifier, and driver stages on PC board A4. The supply and regulator operate to provide an output of nominally 6.3 V dc between A4-E (+) and A4-L (-). The protection circuits disable the heater supply, and also the high voltage cathode supply, if the voltage goes outside the range of ≈6.0 to 6.9 V dc. When proper heater supply output is provided, relay A3K5 is energized to connect the (+) side of the supply to TB1-3, from which it is applied to the TWT through the cathode/heater (+) lead. The regulated (-) output of the supply, supplied to A4-L from the collector of regulator transistor A3Q1. It connects from A4-L to the TWT heater (-) lead, via TB1-2.

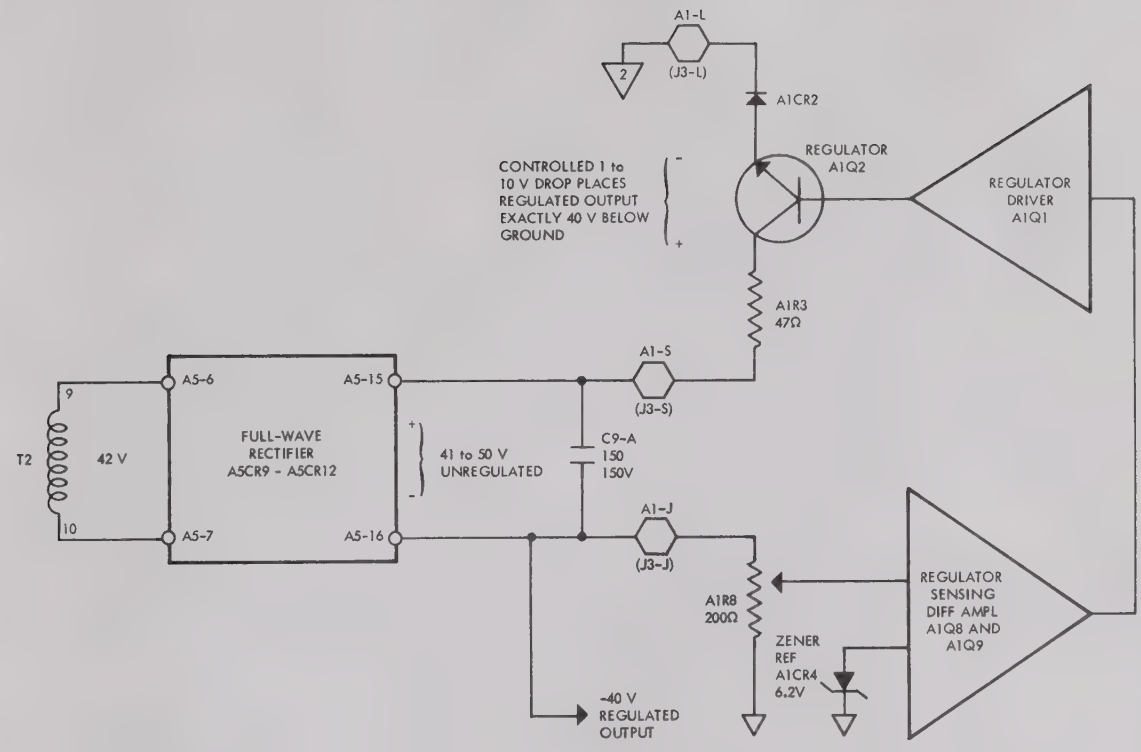
The heater supply regulator circuit operates as follows: A sample of the regulated heater supply voltage is obtained between A4-E and A4-L by a resistor network consisting of A4R12, A4R13, and A4R14. An adjustable output tapped from A4R13 is applied to the base of regulator sensor transistor A4Q5. A reference voltage 4.3 V below the supply (+) terminal is applied to the emitter of A4Q5. A4Q5 is biased to moderate conduction when the supply output is ≈ 6.3 v, because the base bias tapped from A4R13 is ≈ 3 V below the supply (+) terminal, or 1.3 V positive with respect to the A4Q5 emitter. If the output tends to increase to >6.3 V, the increased drop across A4R14 and A4R13 reduces the effective positive bias on A4Q5, decreasing its conduction. If the output tends to decrease to < 6.3 V, the decreased drop across A4R14 and A4R13 increases the positive bias on A4Q5, increasing its conduction .

The conduction of regulator sensor A4Q5 controls the base voltage applied to regulator amplifier A4Q3 and therefore regulates its conduction. The conduction of A4Q3 controls the base-emitter forward bias of regulator driver A4Q4, largely developed across A4R6. The conduction of regulator driver A4Q4 establishes the base-emitter bias for regulator transistor A3Q1 by controlling the current through A4R9 which establishes the voltage between A4-B and A4-A.

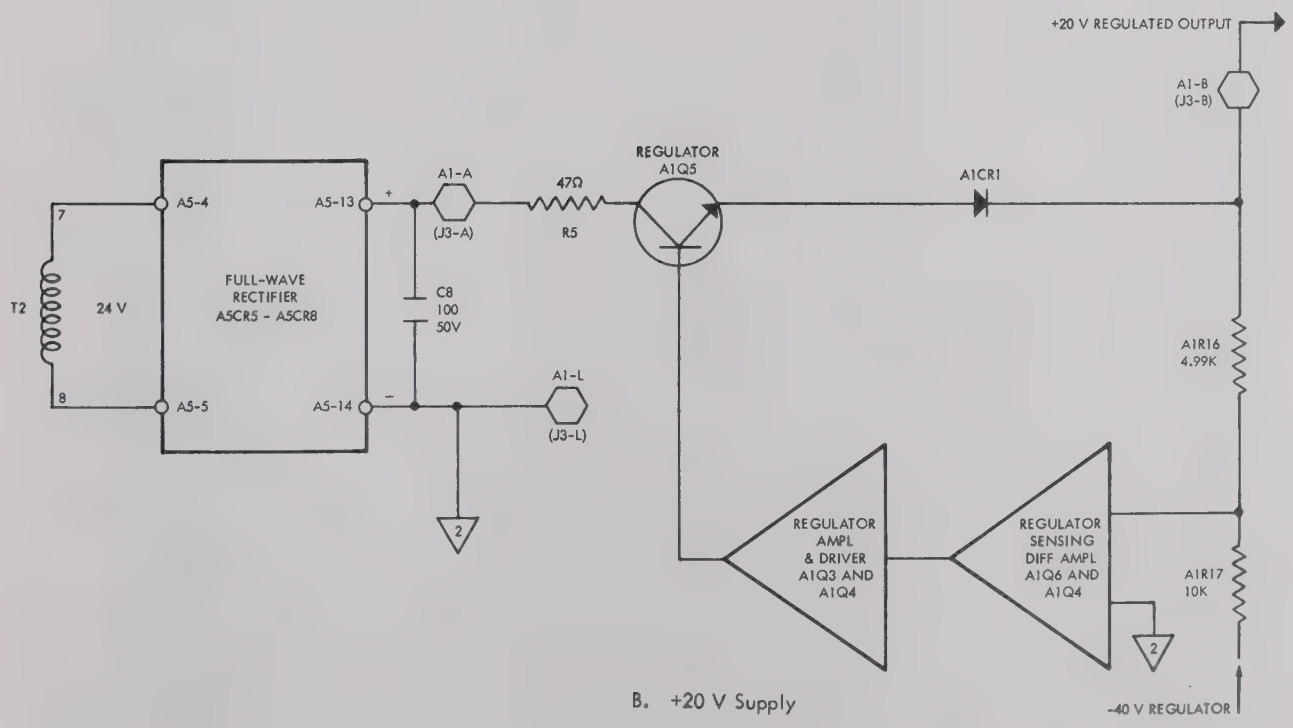
When A4Q5 is conducting moderately, A4Q3, A4Q4 and A3Q1 all conduct moderately, with A3Q1 providing a suitable drop between A4-B and A4-L to maintain the supply (-) terminal (A4-L) ≈6.3 v below the (+) terminal (A4-E). If the output tends to become>6.3 V, A3Q5 decreases conduction and, in turn, causes A4Q3, A4Q4 , and A3Q1 all to decrease conduction. This creates a greater drop across regulator A3Q4 to restore the 6.3 V difference between A4-E and A4-L. If the output tends to become < 6.3 V, A3Q5 increases conduction and, in turn, causes A4Q3, A4Q4, and A3Q1 all to increase conduction. This reduces the drop across regulator A3Q1 to restore the 6.3 V difference between A4-E and A4-L .

4.4.2 HEATER OVERCURRENT PROTECTION CIRCUIT. Resistor A3R21 in the supply (-) output line at the input to the regulator transistor has a resistance of only 0.27 ohms. It serves as an overcurrent sensing resistor without establishing significant voltage drop in the regulator circuit. The voltage developed across A3R21 is applied to overcurrent sensor A4Q2. A4-B is less negative than A4-C, thereby establishing a single forward base bias at A4Q2.

If the heater current increases to >2.3 amps, sufficient forward bias is applied to turn on A4Q2. Turn-on of A4Q2 connects the A4Q4 base to A4-C, which is more negative than the A4 emitter. This cuts offregulator driver transistor A4Q4 which removes the forward bias from regulator transistor A3Q1, with the result that the supply output is cut off. The resulting lack of current at A4-L cuts off relay driver stage A4Q7, causing relay A3K5 to drop out and disconnect the TWT heater from the supply. When A3K5 drops out it cuts off A4Q1 to cause the high voltage protection circuits to disconnect the cathode supply from the TWT, as described in paragraph 4.4.4.



A. -40 V Supply



B. +20 V Supply

FIGURE 4-2. BLOCK DIAGRAM OF REGULATED LOW VOLTAGE SUPPLIES

Since the elimination of excess current removes the forward bias from A4Q2, it cuts off again and the circuit automatically resets itself, supplying (-) voltage to A4-L which is connected through by A4Q7 to operate relay A3K5. If the overload has not been eliminated, the cycle repeats itself, so that relay A3K5 switches back and forth (vibrates).

4.4.3 HEATER OVERVOLTAGE PROTECTION CIRCUIT. Zener diode A3CR2 serves as a reference for the base of heater overvoltage sensor A4Q6. This diode places the junction of A4R18 and A4R2 6.8 V below the supply (+) output at A4-E. The emitter of A4Q6 is connected directly to the supply (-) terminal, A4-L. Resistor A4R18 is factory-selected to establish a base voltage of ≈6.1 v below A4-E at A4Q6, since A4R18 and A4R1 divide the 6.8 V drop provided by A4CR2.

In normal operation, with heater supply output of ≈6.3 v, there is insufficient forward base-emitter bias applied to A4Q6 to exceed the 0.6 V required for turn-on, and A4Q6 remains cut off. With A4Q6 cut off, relay driver A4Q7 is biased to saturation by the + base bias applied through A4R15. The saturation of A4Q7 energizes relay A3K5 to connect the supply (+) output to the TWT heater.

If the supply voltage increases to >6.9 - 7.1 v, the emitter voltage of A4Q6 effectively drops to >0.6 v below the base voltage (which is fixed by zener reference to the (+) side of the supply). A4Q6 is then biased to conduct and the resulting voltage drop across A4R16 eliminates the forward bias on A4Q7. A4Q7 cuts off, de-energizing relay A3K5. This disconnects the TWT heater from the supply output.

4.4.4 RESPONSE OF PROTECTION CIRCUIT HOLD-OFF AMPLIFIER TO DE-ENERGIZATION OF A3K5. When A3K5 is de-energized, which occurs only as a result of heater supply malfunction, the A3K5 from C contact connect the supply (+) output to A4-H. This protection circuit hold-off amplifier A3Q1 is normally forward biased by A4R4 when A4-H is not connected. When forward-biased to saturation under normal conditions, A4Q1 energizes the lamp in A3DSR1. This lamp illuminates the DSR1 photosensitive resistor, reducing its resistance and allowing it to pass the current which keeps A2Q7 cut off and protection relay K3 de-energized (see Figure 4-5). When A4Q1 is cut off, it turns off the lamp in A3DSR1, causing the resistance of the photosensitive resistor to increase and turn on A2Q7 and ptorection relay K3. This causes protection relay K4 to disconnect the high voltage from the TWT cathode (see paragraph 4.5).

4.4.5 HEATER UNDERVOLTAGE PROTECTION CIRCUIT. Zener diode A3CR2 also serves to provide an emitter-bias reference to under-voltage sensor A4Q8. This reference voltage is 6.8V below the supply (+) output at A4-E. The base of A4Q8 is connected to the supply (-) output at A4-L through factory-selected resistor A4R17.

In normal operation, with heater supply output of ≈ 6.3 V, there is insufficient forward base-emitter bias applied to A4Q8 to exceed the 0.6 V required for turn-on, and A4Q8 remains cut off. With A4Q8 cut off, no current is drawn through A4R16, and A4Q9 is thus held cut off since it receives no forward bias. In the cut-off condition, A4Q9 has no effect on the saturated forward-bias of A4Q1 which is provided by A4R4.

If the supply voltage decreases to < 5.7 - 6.0 V, the base voltage of A4Q8 effectively increases to > 0.6 V above the emitter voltage (which remains fixed by zener reference to 6.8 below the (+) side of the supply). A4Q8 is then biased to conduct and the resulting voltage drop across A4R16 also forward-biases A4Q9 to saturation. Conduction of A4Q9 couples the supply (+) output from A4-J (supplied as long as A3K5 remains energized) to the base of A4Q1. This cuts off A4Q1 in a manner equivalent to that described in paragraph 4.4.4, so that the high voltage protection circuits operate to remove high voltage from the TWT.

If the under-voltage condition is so severe that A4Q7 does not conduct enough current to energize relay A3K5, it will drop out and cut off A4Q1 directly, as described in paragraph 4.4.4.

4.5 RELAY INTERLOCKS AND PROTECTION CIRCUITS.

4.5.1 General Operation of the protection relays is described below and summarized in Table 4-2.

4.5.2 OPERATION OF PROTECTION CIRCUITS FROM TURN-ON TO STANDBY MODE (See Figure 4-4 and Schematic D900842). Time-Delay relay K1 is energized during the 90-second warm-up interval that it provides immediately after power turn-on. It operates directly from the 6.3 V ac supply. After K1 closes contacts 8-3 to energize protection relay K2, K1 is de-energized by the Form D K2 contacts. The Form D K2 contacts also provide self-latching in the ground circuit of the K2 coil to keep K2 energized as long as the series string of "Standby Mode" protection loop contacts is closed to complete the 6.3 V ac power circuit to the K2 coil. Contacts contained in this series protection loop include the top and bottom panel interlock, blower airflow vane-operated switch, and an interlock connection through two terminals of each of the plug-in PC cards.

When K2 is operated, one set of Form C contacts breaks the ground connection which energized relay K3 when power was first applied. (K3 remains on, by being self-latched to ground through its Form D contact and the OPERATE pushbutton.) Another set of K2 Form C contacts connects + 26 v dc to the coil of high voltage vacuum relay K4 which enables that relay to operate if K3 is de-energized. The third set of K2 Form C contacts energizes high voltage transformer T1, thereby establishing the Standby Mode.

4.5.3 OPERATION OF OPERATE MODE HIGH VOLTAGE PROTECTION CIRCUITS (See Figure 4-5 and Schematic D900842). Relay K3 is a dynamic protection relay which is energized by K2 when power is originally applied with K2 de-energized. Once K2 is operated to enable the Standby Mode, K3 remains energized through its self-latching Form D contacts and the OPERATE button. When K3 is energized, its Form D contacts break the ground return connection of the K4 coil, so that K4 connot be energized to apply the high voltage cathode supply output to the TWT cathode and the dropping resistor network which supplies the TWT anode electrode.

When the OPERATE button is pressed, the self-latching ground connection for the K3 coil is broken, and K3 will be de-energized if the ground loop is not completed by an alternate path through the dynamic protection circuits contained on PC board A2. These protection circuits include A2Q6 and A2Q7, either of which may be driven to saturation to preserve the ground connection of K3 and thereby prevent the instrument from entering the Operate Mode as described below.

A2Q5 is the helix overcurrent sensing transistor, which is held in saturation unless a helix overcurrent condition exists. When such a condition exists, the positive bias on the A2Q5 base is reduced by current flow through A2R12 and A2R15 so that A2Q5 cuts off and removes the ground connection from the A2Q6 base. This causes A2Q6 to be driven to saturation by the + 26 v bias applied through A2R13.

Table 4-2. Summary of Protection Relay Operation and Function (Continued).

RELAY	ENERGIZED BY	DE-ENERGIZED BY	FUNCTION
K4	K4 is energized by pressing the Operate button, provided K2 is already energized (indicating that all protection circuit interlocks are operating properly) and provided the additional protection circuits in A2 (for helix overcurrent or heater overcurrent or incorrect heater voltage) are not tripped. The K4 coil (yellow lead) receives + 12 V from the N.O. contacts of the K2 Form C set nearest the coil, when K2 is energized. The ground connection for the K4 coil (violet lead) is completed by the Form D contacts of K3, when K3 is de-energized. Since K2 is energized when the instrument enters the standby mode, the final step in turn-on of K4 is to de-energize K3 by pressing the OPERATE button. If the A2 protection circuits are tripped, J4-T will be held at ground, and pressing the OPERATE button will not de-energize K3 to turn on K4.	K4 is de-energized by pressing the Standby or Power Off buttons. After K4 has been energized, pressing the STAND-BY button triggers the same protection circuit trip as a helix overcurrent condition, grounding J4-T to energize K3 to break the K4 coil ground connection. K4 will also de-energize if the protection circuits of A2 are tripped (which energizes K3 to break the K4 coil ground connection) or if any of the series protection circuit interlocks are defeated (which de-energizes K2 to remove + 12 V power from the K4 coil).	When K4 is energized, it applies the high voltage (-) cathode supply output to the TWT. The cathode voltage (red/orn wire) is connected by K4 (via the red/wht wire) directly to pin 3 of TS-1, where it drives the cathode/heater (+) connection (yellow wire) to the TWT. This line also is connected to J6-Z where it drives the anode bias dropping resistors in A3. K4 can be energized only when K3 is de-energized with K2 energized, conditions which can only occur if there are no protection circuit outages and if the OPERATE button has been pressed. When K4 is de-energized, its Form C contacts disconnect high voltage from the TWT.
K5	K5 is energized by Power Turn-on, which supplies regulated power from the 6.3 V heater supply to the K5 coil (+ directly from filter C7 via red wire from J5-E; - from J5-F via J5-L and protection circuit transistor A4Q7 which completes the circuit between J5-L and J5-F provided a heater over-voltage condition does not exist.	K5 is de-energized by heater over-voltage or over-current or Power Turn-Off. Heater over-voltage cuts off transistor A4Q7 to remove the + voltage at J5-F to de-energize the K5 coil. Heater over-current saturates transistor A4Q2 which cuts off regulator driver transistor A4Q4, reducing the conduction of regulator transistor Q1, causing the voltage at J5-L to decrease to the point that K5 drops out.	When K5 is energized, it connects the heater supply (+) to the TWT heater via its Form C contact set. The (+) output at the contact arm (red wire) is connected to J5-J via the N.O. contact (brown wire) from where the + lead connects to terminal 1 of TS-1 via a red/orange wire. If K5 is de-energized by an over-voltage or over-current condition, its N.C. contact (yellow wire) connects the + output from the arm (red wire) to J5-H, where it cuts off transistor A4Q1 to disconnect J5-K from the dc supply + output at J5-E. This de-energizes the lamp in DSR1. The light-sensitive resistor in DSR1 then removes -40 V from J4-E, causing the A2 protection circuits to connect A2-T to ground, thereby energizing K3. This produces high-voltage trip-out and switches the instrument from the "Operate" to the "Standby" Mode.

A2Q7 is held at cutoff by the negative base bias developed through A2R17 whenever the lamp in A3DSR1 is lighted to drive the associated photo-sensitive resistor to heavy conduction. The lamp in A3DSR1 is lighted only when the heater supply is operating properly. Presence of heater over-voltage will de-energize relay A3K5 to remove heater voltage from the TWT. A3K5 will then drive A4Q1 to de-energize the A3DSR1 lamp, causing A2Q7 to be driven to saturation by its base connection to + 26 V through A2R16. Presence of heater under-voltage will also drive A4Q1 to de-energize the DS1 lamp. The filament regulator circuit limits output current to 2.3 amps. Current in excess of that level will also drive A4Q1 to de-energize the DS1 lamp.

If the helix current and heater voltage and current conditions are correct, neither A2Q6 nor A2Q7 will be saturated, and the OPERATE button S4 will break the self-latching ground loop for K3 when pressed. K3 then de-energizes and its Form D contacts complete the ground connection for the coil of high-speed vacuum relay K4. K4 operates within milliseconds to apply the cathode supply high voltage output to the traveling-wave tube through its Form C contacts. The instrument is thus placed in the Operate Mode, with the TWT biased to provide rf amplification.

The Form C contacts on K3 control the STANDBY and OPERATE mode indicator lights. The STANDBY light does not glow when K3 is initially energized because the lights are driven through a coil on T1, which is not energized until K2 is operated to enable the Standby Mode.

When the instrument in Operate Mode, pressing the STANDBY pushbutton applies a negative bias to the base of A2Q5, cutting off the transistor and causing A2Q6 to be driven to saturation momentarily, grounding A2-T. This energizes K3, which then self-latches through its Form D contacts and the OPERATE push-button. The K3 Form D contacts also break the ground connection for the coil of high voltage vacuum relay K4. This relay is thus de-energized, removing the high voltage bias from the TWT cathode and anode so that the instrument reverts to the Standby Mode.

When the instrument is in the Operate Mode, any problem in the "standby mode" series protection loop will cause relay K2 to be de-energized. One set of K2 Form C contacts then de-energizes K4 by removing the + 12 v operating power from the K4 coil. Another set of K2 Form C contacts removes primary power from high voltage transformer T1. The K2 Form D contact completes the ground connection to the coil of time delay relay K1, to start a new turn-on cycle. At the end of 90 seconds, K2 will be re-energized if the problem in the "standby mode" series protection loop has been resolved.

4.6 REGULATED HIGH VOLTAGE CATHODE SUPPLY (See Figure 4-1 and Schematic D900842).

4.6.1 GENERAL. The high voltage cathode supply consists of transformer T1, rectifiers CR11 - 14, voltage doubler capacitors C3 and C4, two voltage doubler resistor assemblies 951079 (R1 - R5 for each voltage doubler capacitor), regulator tubes V1 - V4, and the high voltage regulator amplifier circuits contained on PC board A4.

The rectifier/voltage doubler develops an output voltage of ≈3500 v, with the + terminal at the plate caps of V1 - V4 (the junction of C3 and CR12) and the - terminal at the junction of C4 and C5. The plate-to-cathode conduction of regulator tubes V1 - V4 controls the drop between the supply (+) terminal and chassis ground. The supply (-) terminal is connected to the TWT cathode by relay K4 when all operating conditions are proper. Since the TWT collector is operated at or near ground potential, and the anode bias is developed by a voltage divider between the cathode supply and ground, the ground-reference provided by the regulator tubes establishes the proper cathode-to-ground voltage. When the regulator tubes are biased to light conduction, their plate-to-cathode drop is ≈900 V, and this offsets 900 V of the raw supply voltage to provide a net TWT cathode-to-ground voltage of ≈2600 v. When the regulator tubes are biased to heavy conduction, their plate-to-cathode drop is ≈100 V, and this provides a net TWT cathode-to-ground voltage of ≈3400 V†.

4.6.2 VOLTAGE DOUBLER. Capacitors C3 and C4 each receive half-wave rectified voltage, C3 receiving (+) at its junction with CR12, and C4 receiving (-) at its junction with CR14. The common connection of C3 and C4 acts as the return lead for each, so that the rectified transformer secondary voltage is applied across each capacitor with the proper polarity to make the two add to "double" the rectified voltage at the supply output.

4.6.3 CATHODE SUPPLY FEEDBACK AND REGULATOR AMPLIFIER CIRCUITS. The (-) cathode supply output voltage is applied to the feedback dropping resistor string at A6-A. The feeback string acts as a voltage divider between the (-) cathode supply voltage and + 20 V. It includes A6R1 - A6R7 (which are differenct for each Model). The series string then connects from A6-L to A2-L and through R21 to A2-F. A2R11 and A2R10 complete the string from A2-F to the reference connection at + 20 V (A2-D).

The resistors in the A6 portion of the feedback string are selected to provide a drop that provides ≈0 v at the center of A2R11 when the proper cathode supply output voltage is developed.

A2Q3 and A2Q4 form the differential regulator sensor/amplifier. The base of A2Q3 is returned to ground through A2R6, so that it is biased slightly below ground by base current. The base of A2Q4 is biased from the wiper of A2R11. A2Q3 and A2Q4 operate between + 20 V and - 40 V. When the proper dc output voltage is developd, the bases of A2Q3 and A2Q4 receive almost equal bias, and each conducts moderately.

The voltage developed across A2R9 by the conduction of A2Q4 forward-biases amplifier A2Q1 to moderate conduction. This forward-biases regulator driver A2Q2, since its base is returned to ground. The collector current through A2Q1 and A2Q2 passes through A2R4, developing the control grid bias for the regulator tubes. With the A2Q2 driver stage cut off, - 40 v bias is provided at A2-P. When the driver stage conducts, the grid voltage becomes less negative, to increase the conduction of the regulator tubes.

If the cathode supply output voltage tends to become too high, the increased drop through A2R11 and A2R10 applies a (-) voltage to the base of A2Q4, reducing its conduction. This reduces the forward bias on driver A2Q1, reducing the conduction of it and A2Q2. This shifts the A2-P output closer to - 40 V, therby reducing the conduction of the regulator tubes so that the voltage drop across them increases, thereby reducing the output voltage to the proper value.

Conversely, if the cathode supply output voltage tends to become too low, the reduced drop through A2R10 and A2R11 applies a (+) voltage to the base of A2Q4, increasing its conduction. This increases the forward bias on driver A2Q1, increasing the conduction of it and A2Q2. This reduces the A2-P (-) output,

† The output tap used on T1 is selected to establish proper output voltage with a minimum drop in V1 - V4 (See schematic D900842).

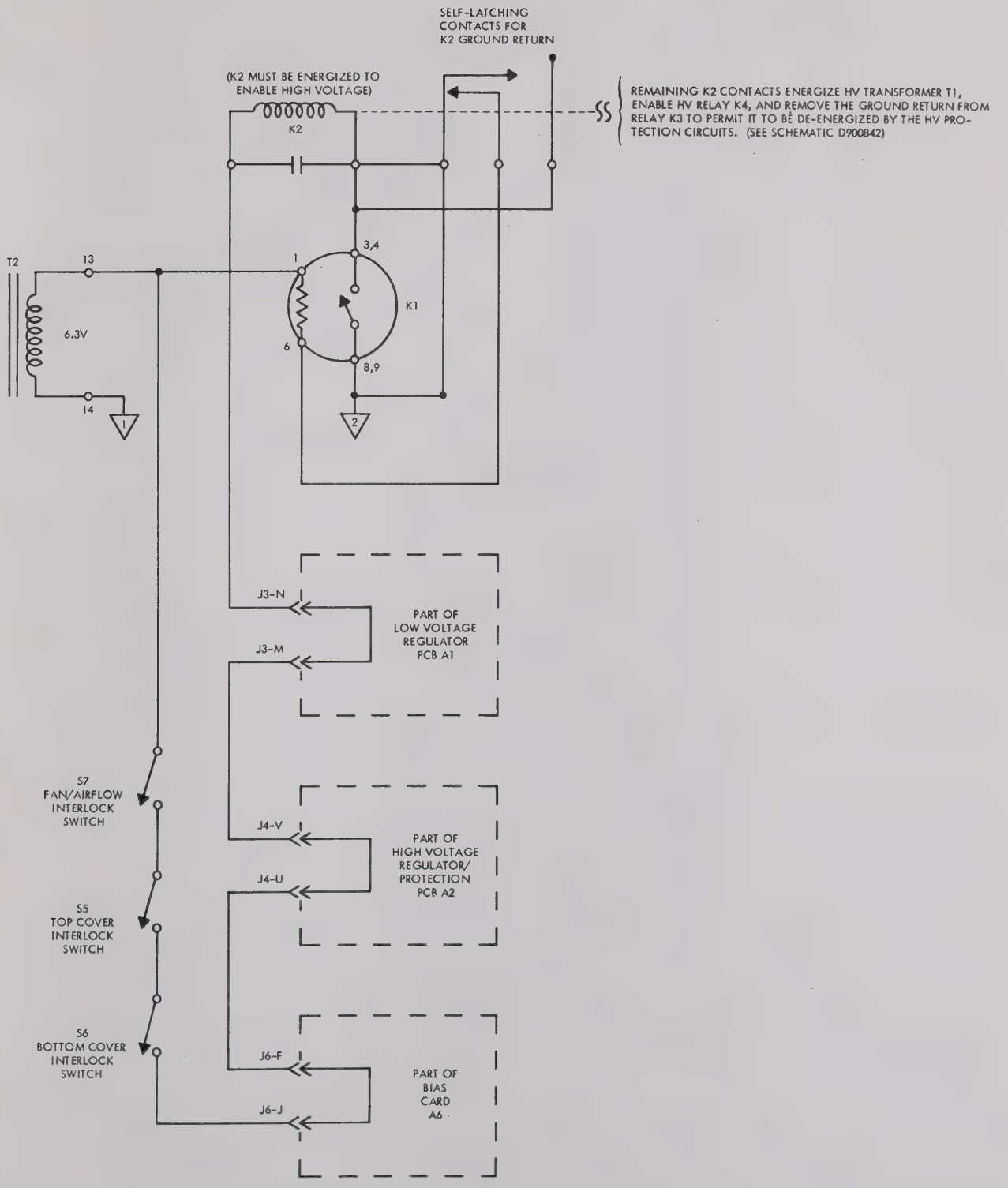


FIGURE 4-4. DIAGRAM OF "STANDBY MODE" PROTECTION CIRCUIT INTERLOCKS INCLUDING RELAYS K1 AND K2

thereby increasing the conduction of the regulator tubes so that the voltage drop across them decreases, thereby raising the output voltage to the proper value.

4.6.4 AC FEEDBACK LOOP. AC feedback to reduce supply output ripple is applied from the supply output through A3C1† to A2-H and to the base of regulator sensor/amplifier A4Q4 through A4R7. Limiter diodes A2CR1 and A2CR2 prevent sudden voltage changes from over-driving the regulator sensor/amplifier.

4.6.5 REGULATOR TUBE TURN-ON CIRCUIT. To assure that the regulator tubes V1-V4 are uniformly turned on whenever the supply turns on, thereby allowing them to equally assume the regulation current load, transistor Q2 on the main chassis is driven from a mid-point tap in the supply feed back string, at A2-L. Before high voltage supply is turned on, + 20 v from the "return" end of the feedback string passes through A2R10, A2R11, R21, and CR18 to bias Q2 to saturation. Q2 then couples - 40 v from through R20 to A2-K, where it is applied to the base of A2Q1. This biases A2Q and A2Q2 to heavy conduction, which reduces the (-) grid bias voltage at A2-P to turn on the regulator tubes to heavy conduction. As the high voltage supply is turned on, and while C11 and C5 charge to the high operating voltage, Q2 keeps the regulator tubes conducting. As the supply reaches and starts to "overshoot" operating voltage, the (-) feedback voltage at the base of A2Q4, amplified across A2R9 (and thereby at a lower impedance level than the Q2 voltage coupled through R20), takes control of A2Q1 and increases the (-) voltage at A2-P to close the regulator feedback control loop. This stabilizes the operating voltage at the proper level.

4.6.6 HIGH VOLTAGE PROTECTION CIRCUITS ON PC BOARD A2. A2Q5 - A2Q7 and the associated components are used to energize protection relay K3 whenever either helix overcurrent or improper heater voltage exist. These circuits are described in paragraph 4.5.3.

4.7 ANODE SUPPLY (See Figure 4-1 and Schematic D900842).

4.7.1 GENERAL. The anode supply voltage is derived from a voltage divider between the cathode supply (-) output voltage and ground. It is therefore positive with respect to the cathode, as required.

4.7.2 ANODE SUPPLY VOLTAGE DIVIDER. The cathode supply output voltage is applied to A6-Z, which is direct - connected to A6-W, since A6R15 and A6R16 are not used. A6-W connects to A6-S through anode adjust resistor A3R2. A6-S connects to ground through A6R8 - A6R14 and A6-M. The full cathode supply voltage is thus divided across A3R2 and A6R8 - A6R14. Anode voltage adjust resistor A3R2 is located at the end of the divider string next to the cathode supply, and its value, compared to the rest of the string, provides an adjustment range of 0 to 100 V with respect to cathode.

4.7.3 ANODE OVERVOLTAGE PROTECTION. Zener diode A4CR1 protects the anode against excess positive voltage or surges. It breaks down if the positive anode-to-cathode voltage exceeds 82V (Model 5010) or 100V (other Models), and clamps the anode to that limiting voltage.

4.8 HELIX SUPPLY (See Figure 4-1 and Schematics D900842 and C900913).

As described in paragraph 4.5.3, the near-ground helix bias is developed from the + 20 v supply through A2R15 and A2R12. The helix bias is connected through diode CR5 between A3-K and the TWT connection at TB1-5. CR5 provides a means of monitoring helix current between TP5 and TP6. When these two test points are shorted to bypass the diode, the current through the shorting jumper can be measured with a clip-on milliammeter.

4.9 OPERATION OF TRAVELING WAVE TUBE.

4.9.1 GENERAL. At frequencies above a few hundred megacycles, conventional vacuum tubes no longer amplify properly because the period of one cycle of the radio frequency wave approaches the time it takes the electrons to travel from cathode to anode (plate) within the tube. As a result the amplification factor of the tube decreases with increasing frequency until no useful gain can be obtained. This is known as the transit time effect.

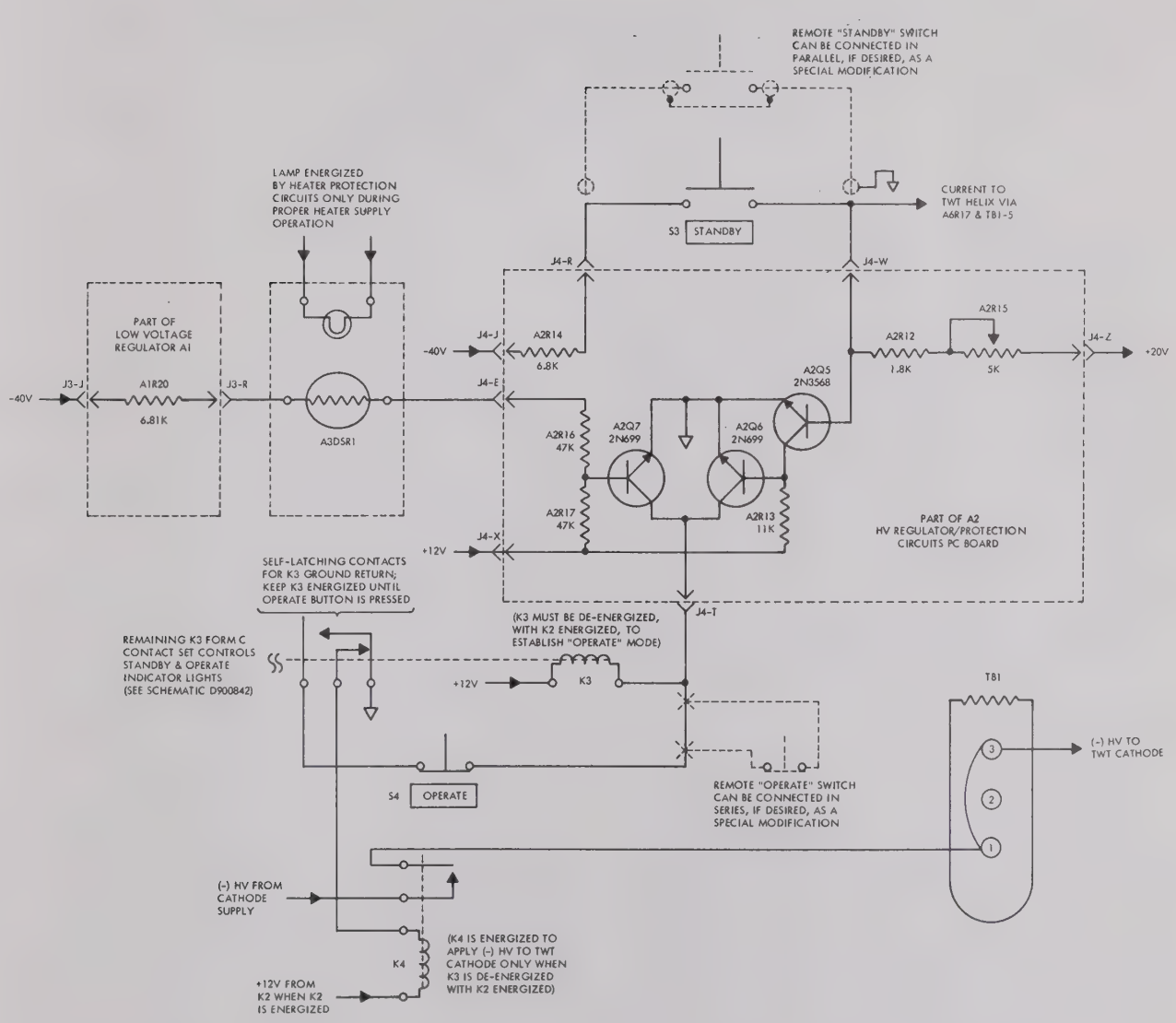
The traveling wave tube (TW tube or TWT) makes use of the transit time effect to provide amplification at microwave frequencies. The TW tube is designed so that a relatively long physical distance exists for interaction between the input RF signal and the electron beam within the tube, permitting distributed interaction for a duration of several cycles. This design provides amplification and permits proper operation over octave bandwidths.

4.9.2 PHYSICAL ARRANGEMENT (See Figure 4-6). The physical arrangement of the TW tube is sown in figure 4-6. All portions of the tube are encapsulated for protection, and hence the envelope, attenuator, couplings, etc. are not visible. The electron gun at one end of the tube is similar to the electron gun used in cathode-ray tubes. The helix is a helical (spring-like) metal wire which extends the length of the TW tube, just inside the envelope, and serves as a slow-wave structure for the rf signal. The input and output couplings are matched to the helix inside the tube envelope, and consist of pins which feed through the tube envelope and are shielded by short cylindrical cavities.

Surrounding the evacuated envelope of the tube is a series of short cylindrical permanent magnets . These magnets are all oriented the same way so that the N pole of one faces the P pole of the adjacent magnet. This produces a strong axial field. This field focuses the electrons in the beam and allows movement only in the direction of the axis of the tube. This focusing method is called periodic permanent magnet (PPM) focusing. An exterior housing completely covers the magnets and tube, and no magnet adjustments are possible. The tube electrodes are connected to wire leads which are brought out through the housing for connection to TB-1.

4.9.3 OPERATION. The electron gun produces a beam of electrons which travels along the axis of the helical wire coil (helix) to the collector, attracted by the positive potential on the collector and helix, and controlled by the anode electrode. The magnetic flux from the surrounding magnet forces the electron beam to follow the axis of the solenoid, which coincides with the axis of the helix, thereby confining the electron beam so that it travels axially along the tube in the space just inside the helix windings. An RF signal at low impedance level is coupled to the helix through the input coupling pin at the electron gun end of the tube. This signal then travels along the metallic path of the helix toward the collector end. The helix serves to slow the effective axial progress of the RF signal by forcing this signal to follow the corkscrew path of the helix wire, while the electron beam inside is free to follow the direct axial path.

† C11 on early production units.


REMOTE "STANDBY" SWITCH CAN BE CONNECTED IN PARALLEL, IF DESIRED, AS A SPECIAL MODIFICATION
LAMP ENERGIZED BY HEATER PROTECTION CIRCUITS ONLY DURING PROPER HEATER SUPPLY OPERATION
CURRENT TO TWT HELIX VIA A6R17 & TB1-5
S3 STANDBY
J4-R
J4-W
PART OF LOW VOLTAGE REGULATOR A1
-40V
J3-J
A1R20
6.81K
J3-R
A3DSR1
J4-J
-40V
A2R14
6.8K
J4-E
A2R15
A2R12
1.8K
5K
J4-Z
+20V
A2Q5
2N3568
A2Q7
2N699
A2Q6
2N699
A2R16
47K
A2R17
47K
A2R13
11K
PART OF A2
HV REGULATOR/PROTECTION
CIRCUITS PC BOARD
+12V
J4-X
J4-T
SELF-LATCHING CONTACTS FOR K3 GROUND RETURN; KEEP K3 ENERGIZED UNTIL OPERATE BUTTON IS PRESSED
(K3 MUST BE DE-ENERGIZED, WITH K2 ENERGIZED, TO ESTABLISH "OPERATE" MODE)
REMAINING K3 FORM C CONTACT SET CONTROLS STANDBY & OPERATE INDICATOR LIGHTS (SEE SCHEMATIC D900842)
+12V
K3
T81
(-) HV TO TWT CATHODE
S4 OPERATE
REMOTE "OPERATE" SWITCH CAN BE CONNECTED IN SERIES, IF DESIRED, AS A SPECIAL MODIFICATION
(-) HV FROM CATHODE SUPPLY
K4
(K4 IS ENERGIZED TO APPLY (-) HV TO TWT CATHODE ONLY WHEN K3 IS DE-ENERGIZED WITH K2 ENERGIZED)
+12V FROM K2 WHEN K2 IS ENERGIZED

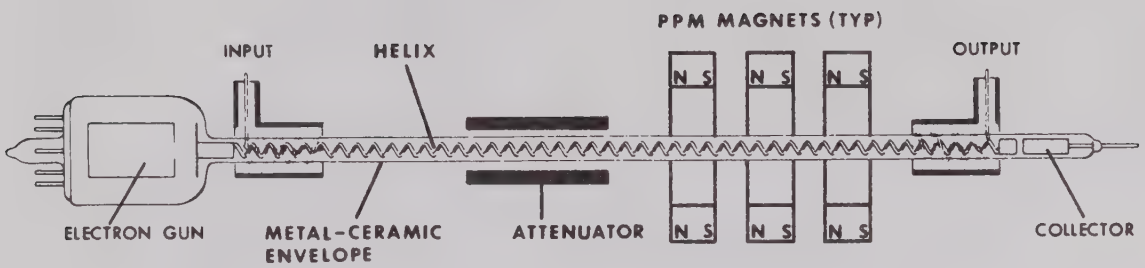


FIGURE 4-6. CUT-AWAY VIEW OF A TRAVELING-WAVE TUBE

The velocity of the electron beam is critically adjusted by the potential difference between the cathode and helix so that the beam velocity along the axis is just slightly faster than the effective axial speed of the RF signal which is progressing along the wire path of the helix. The field of the RF signal acts upon the electron beam as the two progress axially at about the same speed. The RF signal field causes the electrons to bunch within the electron beam in phase with the RF signal, with bunches forming alongside the positive portion of the traveling RF signal and depletions occurring alongside the negative portion. This bunching of the electron beam, in turn, creates a field which induces a constantly-growong amplified RF signal on the helix. The amplified signal is coupled out through the low-impedance output coupling cavity which surrounds the helix at the output (collector) end. Reflections down the helix from output to input end are prevented by the attenuator which surrounds the helix in the center.

The "bunching" of the electron beam in response to the RF input signal, and the generation by the bunched electrons of the field which supplies an amplified RF signal to the helix, is accompanied by a slowing-down of the electrons in the beam. Through this slowing-down process, the electrons lose enough kinetic energy to make up for the increased energy they have transferred to the growing signal on the helix by field radiation. Hence, the electron beam that starts out with its axial velocity critically adjusted slightly greater than the effective axial velocity of the signal along the helix, is gradually slowed down to the speed of the helix signal.

The proper helix-to-cathode voltage is obtained by operating the helix near ground (biased through resistors from the + 20 v supply), and operating the cathode at -1100 V to -3000 V depending upon frequency range (see Addendum A).

Due to the low impedance of the input and output coupling devices and the relatively long effective path for interaction between the helix and the electron beam, frequency-sensitive effects are minimized and uniform amplification over a wide band of frequencies is made possible. The input and output coupling circuits are matched to the input and output signal coaxial transmission lines. These circuits feed through the vacuum envelope of the TW tube, on pins, and are properly matched to the helix inside the tube to allow proper energy transfer to or from the helix with very wide-band transfer characteristics so that the standing wave ratios presented to the input and output signal coaxial transmission lines remains low.

The anode is a positive, low-current, screen-type, nonintercepting electrode within the electron gun which controls beam current and therefore gain and power output of the TW tube. The anode voltage is fixed at a value sufficiently positive with respect to the cathode to cause the electron gun to emit a proper-density electron beam. The proper anode voltage, positive with respect to the cathode, is obtained from a voltage divider between the (-) cathode supply output and ground. The anode voltage depends upon frequency range, and is < 100 v above the cathode(see Addendum A). The collector is connected to ground, and therefore is biased positively with respect to the cathode. It collects the electrons as they complete their path through the TW tube after inducing the signal which the output end of the helix supplies to the output coupler. The effective positive dc bias applied to the helix as a result of the helix-to-cathode voltage provides continued attraction for the electron beam as it progresses along the tube.

4.9.4 OUTPUT CHARACTERISTICS. The TW tube provides gain of 30 db at rated power output (+ 40 dbm, 1 GHz - 11 GHz). It also provides small-signal gain of >30 db at a power output level of + 10 dbm. Thus, it provides useful amplification for input signals ranging from < - 20 dbm to + 10 dbm. The proper load impedance for correct output matching is 50 ohms. The tube may be operated into an RF load which is sufficiently matched to offer a VSWR of less than 3:1. To obtain rated power, the load must offer a VSWR of $\leqq$ 1.5:1. Operation with a VSWR >3:1 may damage the TW tube.

SECTION 5

MAINTENANCE

SAFETY PRECAUTIONS

Voltages of up to -3500V are exposed inside the chassis of this instrument. Interlock switches turn off the high voltage if either the top or bottom cover is removed. To make certain tests and measurements, it is necessary to defeat the interlock switches to turn on high voltage. When working inside the chassis, keep high voltage off except when necessary for measurements. Observe extreme caution when making high voltage measurements.

5.1 PERIODIC MAINTENANCE.

Every few months perform the following maintenance on the instrument:

a. Remove the top and bottom cover plates by removing their attaching screws. Then blow out all accumulated dust with low-pressure forced air. Re-install the top and bottom cover plates.

b. Remove the six screws which attach the vent grille to the panel adjacent to the RF connectors (normally front panel; rear panel on Option 1) to obtain access to the air intake filter. Clean the filter, and while the filter is removed, apply one or two drops of light machine oil to the blower bearings. Then replace the filter and install the grille.

5.2 SUPPLY VOLTAGE MEASUREMENT AND CALIBRATION.

5.2.1 GENERAL. Test points for the major supply voltages and TWT electrode currents are provided on a panel which is exposed when the top cover is removed (see Figure 5-1). Other voltages are conveniently available at the wire terminals of PC connector J4 on the bottom side of the chassis (see Figure 5-2).

Note that on production units having Serial Number (S/N) 252 & up, the HTR (+) is common-connected to the cathode, and a separate HTR - test point (TP8) is provided. Units S/N 251 & below which have been returned to the factory for service have been converted to this configuration so that TP8 on the test point panel reads HTR -. All other units S/N 251 & below have the HTR - common-connected to the cathode, and the separate test point, TP8, is labeled HTR +.

Suitable Test Instruments for these and other measurements are listed in Table 5-1. The voltage measurements are summarized in Table 5-2.

WARNING

The CATH, HTR, and ANODE test points are at high voltage levels when the instrument is in Operate Mode. Suitable high-voltage measurement techniques and extreme caution must be used.

5.2.2 MEASUREMENT AND CALIBRATION OF LOW VOLTAGE SUPPLIES. A check of the supply outputs should be made as the first step in a routine performance check or in locating the cause of malfunction. The low voltage supplies, listed in Group 1 of Table 5-3, should be checked first, since the high voltage supply and the protection circuits within the instrument cannot operate properly with out-of-spec low voltages. Make the low voltage measurements using an accurate digital meter in accordance with the following procedure.

a. Place the instrument horizontally on a sturdy bench and remove the top cover plate.

b. DO NOT defeat the top interlock switch (S5, Figure 5-1; i.e. do not rest a block of wood on it.

c. Connect the line cord to a suitable 3-prong grounded receptacle offering the same voltage for which Line Voltage Switch S2 is set (normally 115 V).

d. Press the ON button. It should light, and after a 90-second warm-up period, the STANDBY lamp should not light.

WARNING

If the STANDBY lamp lights, it indicates that the interlock switch has been defeated and the high voltage cathode supply is on. This is not necessary or safe for making low voltage measurements.

e. -40 V DC Supply Voltage Check. Connect the probe of the DC Digital Voltmeter to TP2 (-40 V), with the return lead to TP3 (GND). The voltage should be 40.00 V ± 0.01 V.

f. -40 V DC Supply Calibration. If the voltage measured in step e. is incorrect, adjust A1R8 (Figure 5-1), to obtain the proper voltage. If the proper voltage cannot be obtained, refer to Table 5-5.

g. -40 V DC Supply Ripple Check. Set the Oscilloscope for AC coupling. Connect the oscilloscope probe to TP2 (-40 V), with the return lead to TP3 (GND). The ripple should be less than 5 mv peak-to-peak.

Table 5-1. Recommended Test Equipment

Instrument	Important Performance Requirements	Recommended Mfr & Model No.
RF Sweep Oscillator	Provide output of ≧ +15 mw within the frequency range of the Model 5000 series amplifier under test.	Alfred Model 650 Alfred Model 651 (1 - 2 GHz) Alfred Model 652 (2 - 4 GHz) Alfred Model 653 (4 - 8 GHz) Alfred Model 654-S1 (7 - 12.4 GHz)
RF Sampler/Attenuator *	Permit leveling and power level adjustment of the Sweep Oscillator above over a range of > 30 db, for use with Models 5010, 5020, and 5030.	Alfred Model 1151 (1 - 2 GHz) Alfred Model 1152 (2 - 4 GHz) Alfred Model 1153 (4 - 8 GHz)
Waveguide Attenuator,* (2) Waveguide-to-coax Adapters, a coaxial 6 db directional coupler*, and a crystal detector*	Permit leveling and power level adjustment of the X-band Sweep Oscillator over a range of > 30 db, for use with Model 5040 only.	H.P. Model X382A Attenuator (8.2 - 12.4 GHz) H.P. Model X218A Adapters Narda Model 3045-6 Series Coupler Alfred Model 1001 Crystal Detector
Coaxial (Type N) RF Load Termination	Capable of dissipating 15 watts.	NARDA Model 369NM or equivalent
3-DB Coaxial Attenuator	Provide 3 db, 6 db, and 20 db attenuation, 1-12.4 GHz, for isolation and attenuation between RF Sweep Oscillator and amplifier under test.	Narda Model 757
Coaxial Power Attenuator	Provide > 35 db attenuation and accept +45 dbm input power; accurately calibrated.	Narda Model 768-20 + Narda Model 757-20 or a suitable flat coupler + 10 db attenuator such as Narda Model 3040-30 Series + Narda Model 757-10
Crystal Detector	Flat performance, ±0.5 db, 1 - 12.4 GHz, capable of handling power levels up to 20 dbm, for amplifier output measurement.	Alfred Model 1001 (or Alfred Model 1403 if used with Model 8000/7051)
Power Meter and Thermistor Mount	Power meter with attenuator pads capable of measuring +10 dbm to -20 dbm.	Alfred Model 8000/7051 Sweep Network Analyzer or H.P. Model 431B Power Meter and Model 478A Thermistor Mount
Oscilloscope	General-purpose voltage and ripple measurement, 5 mv/cm to > 1 V/cm sensitivity range, 600 V maximum input voltage.	Tektronix Model 533 with Type H Plug-in unit and standard P6006 10:1 divider probe
Capacitive Isolator Box	Provide HV DC isolation to permit measurement of ac ripple on the cathode supply at an elevated voltage of up to 3050 V, with the oscilloscope listed above.	Construct: See Figure 5-4
Digital Voltmeter	DC voltage measurements, 0 - 1000 V range, 5-digit, 0.02% accuracy.	Singer-Ballantine Model 3570 Series with Model 3572 DC Converter Module
DC Voltage Divider Box	Provide accurate 10:1 DC voltage division to permit measurement of HV DC voltage up to 3500 V with 0.25% accuracy.	Construct: See Figure 5-3
DC Milliammeter/Floating DC Voltmeter	DC current measurements, 1 ma to > 100 ma full scale; DC voltage measurements of 0 - 50 V floating at up to 3500 V.	Triplett Multimeter: Model 630 or Model 800
Spectrum Analyzer	1 - 12 GHz, 1 KHz IF bandwidth, for spurious noise checks.	Singer Instrumentation Model SPA-3000

*Not required when sweeper is internally leveled.

Table 5-2. Summary of Voltage Measurements at Chassis Test Points

GROUP 1 - Measured with respect to ground (TP3) with standard digital meter, with high voltage held off by not defeating the cover interlock switches. (Listed in preferred order of measurement.)

Supply	TP #	DC Voltage & Tolerance	AC Ripple
-40 V	TP2 (-40 V)	40.00 V ±0.01 V*	5 mv maximum
+20 V	TP1 (+20 V)	20.0 V ±1.0 V	5 mv maximum
Heater Supply	TP8 (HTR -, S/N 252 & up)† (HTR +, S/N 251 & below)†	6.3 V ±0.2 V*	50 mv maximum
Screen Bias for V1-V4	J4-B	~~+130~~ +90 V ±5 V**	100 mv maximum
Relay Supply	J4-X	12.5 V ±1.5 V**	700 mv maximum

GROUP 2 - Measured with respect to ground (TP3 or chassis) with High Voltage Digital Meter or suitable voltage-divider probe, with high voltage on in the Operate Mode.

CAUTION

Switch Instrument to Standby Mode when making test connections. Then switch to Operate Mode for measurements.

Supply	TP #	DC Voltage & Tolerance	AC Ripple
Cathode	TP9 (CATH)	-1100 V to -3050 V; as factory-set for each instrument. Refer to Addendum A in the envelope at the rear of this manual for the specific voltage. This voltage should be held within ±0.25% (i.e. ±7.5 V at 3000 V)*	10 mv maximum

GROUP 3 - Measured by making a measurement with respect to ground (TP3 or chassis) with a High Voltage Digital Meter or a suitable voltage-divider probe, and subtracting the measured voltage from the cathode supply voltage measured in Group 2 above.††

CAUTION

Switch Instrument to Standby Mode when making test connections. Then switch to Operate Mode for measurements.

Supply	TP #	DC Voltage & Tolerance	AC Ripple
Anode	TP7 (ANODE)	0 V to < 100 V positive with respect to cathode; as factory-set for each instrument. Refer to Addendum A in the rear of this manual for the specific voltage.* (Since this voltage is tapped from the cathode supply, its accuracy is determined by that of the cathode supply.)	(10 mv maximum; covered by cathode supply measurement in Group 2 above)

* This supply may be adjusted. Follow the procedure given in Paragraph 5-2.

** This supply is unregulated. Nominal voltage shown applies only when operation is at normal 115 V line voltage.

† Jumper TP9 (CATH) to TP3 (GND) for this measurement.

†† By using a voltmeter having both leads floating and insulated to withstand 4 KV, the anode voltage can be measured directly between TP7 (ANODE) (+) and TP9 (CATH) (-). This method is not recommended because of the safety hazards associated with the use of floating meters.

h. +20 V DC Supply Voltage Check. Connect the probe of the DC Digital Voltmeter to TP1 (+20 V), with the return lead to TP3 (GND). The voltage should be 20.0 V ±1.0 V. If the voltage is incorrect, refer to Table 5-5.

i. +20 V DC Supply Ripple Check. Set the Oscilloscope for AC coupling. Connect the oscilloscope probe to TP1 (+20 V), with the return lead to TP3 (GND). The ripple should be less than 5 mv peak-to-peak.

j. Press the OFF button.

k. Replace the instrument top cover plate.

l. Turn the instrument over, so it rests on its top, and remove the bottom cover plate.

m. DO NOT defeat the bottom interlock switch (S6, Figure 5-2); i.e., do not rest a block of wood on it.

n. Press the ON button.

o. Heater Supply DC Voltage Check. Double-check that the unit is NOT in Standby or Operate Mode. Then connect the probe of the DC Digital Voltmeter to TB1-2 (HTR -), with the return lead to TB1-1 (HTR +). The voltage should be 6.3 V ±0.2 V.

NOTE: Alternately measure between the following test points on top side: HTR (-) and CATH.

p. Heater Supply DC Voltage Calibration. If the voltage measured in step o is incorrect, adjust A4R13 (Figure 5-1) to obtain the proper voltage. If the proper voltage cannot be obtained, refer to Table 5-6.

q. Heater Supply Ripple Check. Set the oscilloscope for ac coupling. Connect the oscilloscope probe to TB1-2 (HTR -), with the return lead to TB1-1 (HTR +). The ripple should be less than 50 mv peak-to-peak.

r. (Deleted)

s. Regulator Tube Screen Bias Supply DC Voltage Check. Connect the return lead of the DC Digital Voltmeter to the chassis, and touch the probe to J4-B (the second pin from the inboard end of the connector). The voltage should be 130 V ±5 V (with nominal 115 V ac line). If the voltage is incorrect, check A5CR1 - A5CR4, A2R1, A2R2, C6A and C6B and associated components.

t. Regulator Tube Screen Bias Supply Ripple Check. Connect the oscilloscope return lead to the chassis and touch the probe to J4-B. The ripple should be less than 100 mv peak-to-peak. If ripple is excessive, check C6A and B.

u. Relay Supply DC Voltage Check. Connect the return lead of the DC Digital Voltmeter to the chassis, and touch the probe to J4-X (the third pin from the outboard end of the connector). The voltage should be 12.5 V ±1.5 V (with nominal 115 V ac line). If the voltage is incorrect, check A5CR13 - CR16, C10, and associated circuits.

NOTE: On units S/N 31 & below, proper voltage is 26 V ±3 V.

v. Relay Supply Ripple Check. Connect the oscilloscope return lead to the chassis and touch the probe to J4-X. The ripple should be less than 700 mv peak-to-peak. If ripple is excessive, check C10.

w. Press the OFF button.

x. Replace the bottom cover plate.

5.2.3 MEASUREMENT AND CALIBRATION OF HIGH VOLTAGE SUPPLIES. The high voltage supplies, listed in Groups 2 and 3 of Table 5-2, should be checked using high voltage measurement techniques and the following procedure:

a. Place the instrument horizontally on a sturdy bench and remove the top cover plate.

b. Defeat the top interlock switch (S5, Figure 5-1) by resting a wood block on its operating button.

c. Connect the line cord to a suitable 3-prong grounded receptacle offering the same voltage for which Line Voltage Switch S2 is set (normally 115 V).

d. Press the ON button. It should light, and after a 90-second warm-up period, the STANDBY lamp should light.

WARNING

DO NOT press the OPERATE button until told to do so in this procedure, because this energizes the high voltage supplies which must remain off until test connections have been made.

e. Verify that the DC divider box (Figure 5-3) has been set to exactly 90 Megohms ±0.01% by checking it with a resistance bridge or as follows: Connect the "10 KV" terminal of the DC divider box to the Model 5000 -40 V test point (TP2). Connect the DC Digital Voltmeter (DVM) probe to the 1 KV terminal of the DC divider box. Connect the DVM return lead to chassis ground. Adjust R10 in the DC divider box until the voltmeter reads 4.000 V ±0.002 V.

Cathode Supply DC Voltage Check.

f. Connect the "10 KV" terminal of the DC divider box to the CATH test point (TP9). Leave the DVM probe connected to the "1 KV" terminal of the DC divider box and the DVM return lead connected to chassis ground.

g. Press the OPERATE button to turn on high voltage.

h. The DVM reading, multiplied by 10, indicates the cathode supply voltage, which should be within ±0.25% of the voltage specified in Addendum A in the envelope at the rear of this manual.

i. Cathode Supply DC Voltage Calibration. If the voltage measured in step h. is incorrect, adjust A2R11 to obtain the proper voltage. If the proper voltage cannot be obtained, refer to Table 5-7.

j. Press the STANDBY button.

Anode Supply DC Voltage Check.

k. Connect the "10 KV terminal of the DC divider box to the ANODE test point (TP7). Leave the DVM probe connected to the "1 KV" terminal of the DC divider box and the DVM return lead connected to chassis ground.

l. Press the OPERATE button to turn on high voltage.

m. The DVM reading multiplied by 10, indicates the voltage between the anode and ground. Subtract this voltage from the cathode supply voltage measured in step h. or adjusted in step i. This gives the anode voltage, in the range 0 to < 100 V, which should be within 1% of the voltage specified in Addendum A in the envelope at the rear of this manual.

n. Anode Supply DC Voltage Calibration. If the voltage measured in step m. is incorrect, adjust A3R2 to obtain the proper voltage. If the proper voltage cannot be obtained, refer to Table 5-7.

o. Press the STANDBY button. Disconnect the DVM and the DC divider box.

High Voltage (Cathode) Supply Ripple Check.

p. Connect the input terminal of the capacitive isolator box (Figure 5-4) to the CATH test point (TP9). Set the oscilloscope for ac coupling, and connect its probe to one of the output terminals on the capacitive isolator box. Connect the oscilloscope return lead to chassis ground.

q. Press the OPERATE button to turn on high voltage.

r. The ripple should be less than 10 mv peak-to-peak.

s. Press the STANDBY button. If the ripple was excessive, check capacitors C1 through C5. Disconnect the capacitive isolator box and oscilloscope.

t. Press the OFF button.

u. Unless TW tube currents are to be measured in accordance with the paragraph below, remove the block from the top interlock switch S5 and replace the top cover plate.

5.2.4 MEASURING TW TUBE CURRENTS. The bulk of the electron beam current of the TW tube, which originates at the cathode, is collected by the collector electrode. The remainder is intercepted by the helix. These currents must not exceed the power dissipating capability of the electrodes. In addition, excessive helix current is an indication that the tube has become defocused, a condition in which the beam no longer follows a true axial path. This reduces the available amplification. On the Model 5010, the helix is grounded to the tube body and its current cannot be monitored. To measure TW tube currents, proceed as follows (see Table 5-3):

a. Place the instrument horizontally on a sturdy bench and remove the top cover plate.

b. Defeat the top interlock switch (S5, Figure 5-1) by resting a wood block on its operating button.

c. Connect the line cord to a suitable 3-prong grounded receptacle offering the same voltage for which Line Voltage Switch S2 is set (normally 115 V).

d. Press the ON button. It should light, and after a 90-second warm-up period, the STANDBY lamp should light.

Collector Current Measurement.

e. If a clip-on milliammeter is to be used, connect a shorting lead between the COLL (+) and GROUND test points (TP3 and TP4). If a standard milliammeter is to be used, connect its + lead to the COLL (+) test point (TP4).

f. Press the OPERATE button to turn on high voltage.

g. If a clip-on milliammeter is being used, clamp its probe around the shorting lead connected in step e. If a standard milliammeter is being used, complete its test connections by connecting its (-) lead to the GROUND test point (TP3).

h. The collector current reading should be within a few ma of the "Normal Cathode Current" entry in Addendum A in the envelope at the rear of this manual. The reading should never exceed the maximum limits listed below:

MODEL	MAXIMUM COLLECTOR CURRENT
5010	45 ma
5020	100 ma
5030	60 ma
5040	70 ma

If excessive current is drawn, the TW tube must be replaced.

i. Press the STANDBY button.

Helix Current Measurement Without RF Drive (Models 5020 - 5040 only).

j. If a clip-on milliammeter is to be used, connect a shorting lead between the HELIX + and HELIX (-) test points (TP5 and TP6), and clamp the milliammeter probe onto this lead. If a standard milliammeter is to be used, connect its (+) lead and (-) leads to the HELIX (+) and HELIX (-) test points, respectively.

k. Press the OPERATE button to turn on high voltage.

l. The helix current reading should be approximately that shown as "Normal Helix Current" in Addendum A in the envelope at the rear of this manual. It should never exceed 5 ma and is typically < 2 ma.

Helix Current Measurement with RF Drive (Models 5020 - 5040 only).

m. Leave the milliammeter connected as in step j.

n. Terminate the RF OUT connector with a 10-watt, 50 Ω load.

Table 5-3. Current Measurements at Chassis Test Points

NOTE: These currents are measured either by connecting a milliammeter between the test points indicated or by connecting a jumper wire between the test points and making the measurement with a clip-on milliammeter.

CAUTION

Switch instrument to Standby Mode when making test connections. Then switch to Operate Mode for measurements. The instrument should be operating at rated rf power output for these measurements.

Current	TP # to TP #	Acceptable Current Level
Helix	TP5 (HELIX +) to TP6 (HELIX -)	5 ma max. with +40 dbm rf output (Models 5010-5030) 7 ma max. with + 40 dbm rf output (Model 5040)
Cathode	TP4 (COLL +) to TP3 (GROUND)	45 ma max. to 100 ma max.; depends upon instrument model. Refer to Addendum A in the envelope at the rear of this manual for the specific maximum current.

o. Connect a swept rf source to provide a +10 dbm signal to drive the RF IN connector, as shown in Figure 5-5.

p. The helix current should increase above that measured in step l., but should not exceed 5 ma (typically 4 ma) in Models 5020 and 5030. It should not exceed 7 ma (typically < 5 ma) in Model 5040.

q. Press the OFF button.

r. Remove the block from the top interlock switch S5 and replace the top cover plate.

5.3 CHECKING AND ADJUSTING OPERATION OF PROTECTION CIRCUITS.

5.3.1 GENERAL. The protection circuits are designed to be fail-safe, and the active stages are not subject to significant in-service performance variations. Nevertheless, it may be desired to verify that the protection circuits are functioning properly. This can be done using the procedures in the following paragraphs.

5.3.2 CHECKING HEATER SUPPLY OVERVOLTAGE AND OVERCURRENT PROTECTION CIRCUITS. Make a test set-up to measure the heater supply voltage as directed in steps a. - d. and step o of paragraph 5.2.2 (leave the instrument top cover off for access to the adjustments). Then proceed as follows:

Heater Overvoltage Trip-out Check and Adjustment.

a. Adjust A4R13 CW to increase the output voltage to 6.9 V. Trip-out will be indicated by a sudden drop of the voltage to 0 as relay A3K5 trips out.

b. If trip-out does not occur at 6.9 V, increase the voltage further, to a maximum of 7.15 V, to see whether trip-out occurs. If trip-out occurs at any voltage between 6.9 V and 7.15 V, it indicates proper operation.

c. If trip-out occurs outside the 6.9 - 7.15 V range, change the value of A4R18 to correct it. The factory-selected value of A4R18 is given in Addendum A in the rear of this Instruction Manual. The resistance value of R18 should be increased to lower the trip-out voltage and decreased to raise the trip-out voltage.

Heater Overcurrent Trip-out Check.

d. Adjust A4R13 CCW until the heater supply comes back on.

e. Then continue the CCW adjustment to set the voltage to 6.3 V.

f. Connect a temporary jumper between TB1-1 (HTR +) and TB1-2 (HTR -) terminals. This should cause audible vibration of relay A3K5 as it clicks open and closed in response to the overload. If no vibration is heard, observe the relay, which is located underneath the A3Q1 heat sink on the top side of the chassis. (The relay should vibrate because it opens in response to the short-circuit overcurrent, and then closes again because the short circuit was disconnected by the relay when it opened. When the relay closes again, the short circuit is restored, causing a repeat of the relay operation.)

g. Remove the jumper between TB1-1 (HTR +) and TB1-2 (HTR -).

h. Disconnect the digital voltmeter from TB1.

i. Press the OFF button.

j. Replace the instrument bottom cover.

5.3.3 CHECKING AND ADJUSTING HEATER SUPPLY UNDERVOLTAGE PROTECTION CIRCUIT.

WARNING

High voltage will be turned on during this procedure. Use an insulated screwdriver and exercise extreme caution when adjusting A4R13.

a. Connect a floating, insulated multimeter between TP8 (HEATER -) and TP9 (CATHODE).

b. Defeat the top interlock switch (S5, Figure 5-1) by resting a wood block on its operating button.

c. Press the ON button. The STANDBY lamp should light after 90 seconds.

d. After the STANDBY lamp lights, press the OPERATE button to turn on high voltage.

e. Carefully adjust A4R13 CCW to decrease the heater supply voltage to 6.0 V. Trip-out will be indicated by the OPERATE lamp going out and the STANDBY lamp coming on.

f. If trip-out does not occur at 6.0 V, decrease the voltage further, to a minimum of 5.7 V, to see whether trip-out occurs. If trip-out occurs at any voltage between 5.7 V and 6.0 V, it indicates proper operation.

g. If trip-out occurs outside the 5.7 - 6.0 V range, turn off power and change the value of A4R17 to correct it. The factory-selected value of A4R17 is given in Addendum A in the rear of this Instruction Manual. The resistance value of A4R17 should be increased to raise the trip-out voltage, and should be decreased to lower the trip-out voltage.

h. After completing this check, carefully adjust A4R13 to set the heater voltage to 6.3 V.

i. Press the OFF button and disconnect test equipment.

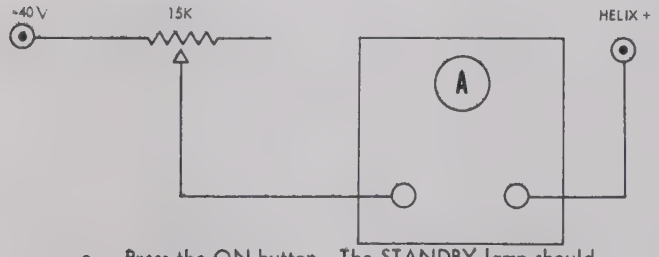
5.3.4 CHECKING AND ADJUSTING HELIX OVERCURRENT PROTECTION CIRCUIT.

WARNING

High voltage will be turned on during this procedure. Use an insulated screwdriver and exercise extreme caution when adjusting A2R15.

a. Connect a jumper between TP6 (HELIX -) and TP3 (GND).

b. Connect a 15 K potentiometer in series with a dc milliammeter, between TP5 (HELIX +) and TP2 (-40) (see diagram below). Initially set the 15 K potentiometer to provide maximum resistance.



c. Press the ON button. The STANDBY lamp should light after 90 seconds.

d. After the STANDBY lamp lights, press the OPERATE button to turn on high voltage.

e. Slowly adjust the 15 K potentiometer in series with the milliammeter to reduce its resistance and increase the current until trip-out occurs, and note the milliammeter reading which produces trip-out. Trip-out will be indicated by the OPERATE lamp going out and the STANDBY lamp coming on.

f. If trip-out does not occur at a current reading of 5 ma on the milliammeter†, adjust A2R15 slightly, and repeat the procedure until A2R15 is set to produce trip-out at a current of 5 ma†. Adjust A2R15 CW to reduce the trip-out current, and CCW to increase the trip-out current. To repeat the checkout procedure, first adjust the 15 K potentiometer to maximum resistance (minimum current reading on the milliammeter), and then press the OPERATE button and repeat step e.

g. After completing this check, press the OFF button.

h. Remove the jumper installed between TP6 (HELIX -) and TP3 (GND).

i. Disconnect the milliammeter.

j. Replace the instrument top cover.

5.4 CALIBRATION AND INTERNAL ADJUSTMENTS.

Calibration and adjustment procedures for supply voltages are included with the measurement procedures given in paragraph 5.2. Calibration and adjustment procedures for the protection circuits are included with the checkout procedures given in paragraph 5.3.

5.5 PERFORMANCE VERIFICATION.

5.5.1 POWER OUTPUT AND FUNCTIONAL PERFORMANCE CHECK. Proceed as follows (see Table 5-1 and Figure 5-5):

a. Obtain a signal generator which can be adjusted to cover the same frequency band as the Model 5000 Series Amplifier being tested, which is specified in Table 1-1. A suitable instrument would be an ALFRED Sweep Oscillator which can be swept across the operating band of the amplifier.

b. Connect to the signal generator rf output connector a flat attenuator which, in conjunction with any power level control provided in the signal generator, will permit output power to be held to less than +10 dbm across the band.

c. Connect to the Signal Generator rf output line, in series with the attenuator (if used), an ALFRED Model 1403 or 1404 crystal detector which has been calibrated for direct reading power measurement on the ALFRED Model 8000/7051 or 8000/7052 Sweep Analyzer.

NOTE: If an ALFRED Sweep Analyzer is not available, use any conventional power meter which can measure power levels up to +10 dbm.

d. While monitoring the signal generator rf output, verify and/or adjust it so that the level does not exceed +10 dbm across the full swept band.

NOTE: If an ALFRED Model 8000/7051 Sweep Network Analyzer is not available and power output from the rf signal generator is not leveled, make a plot of signal generator output power across the band for later use in comparison with the amplifier output. The Model 8000/7051 will permit simultaneous comparison and eliminate need for a plot of the input power.

† 7 ma on Model 5040

e. Disconnect the crystal detector or power meter sensor from the signal generator rf output line.

f. Connect to the amplifier RF OUT connector a flat 30 db attenuator, and connect to the attenuator output the ALFRED Model 1403 or 1404 Crystal Detector used with the ALFRED Model 8000/7051 or 8000/7052 for power measurements in step d.

NOTE: If an ALFRED Sweep Analyzer is not available, use an attenuator having an attenuation sufficient to reduce output power to within the operating range of the power meter sensor used. The output power from the Model 5000 Series Amplifier may be as high as +45 dbm.

g. Without changing the signal generator control settings or removing the attenuator used in the power check of step d, connect this rf signal line to the RF IN connector of the Model 5000 Series Amplifier.

h. Press the POWER-ON pushbutton on the front panel of the Model 5000 Series Amplifier so that it lights to indicate power ON.

i. After a warmup period of about 90 seconds, the STANDBY pushbutton should light, indicating that the instrument has automatically entered the Standby Mode. At that time press the OPERATE pushbutton, which should light to indicate that RF output is on.

j. Monitor the power output across the full operating band of the amplifier. With an input level of about +10 dbm, the output level should exceed +40 dbm across the band.

5.5.2 AMPLIFICATION CHECK. Proceed as follows:

a. If an ALFRED Model 8000/7051 Sweep Network was used for measuring absolute power output in the preceding test, it is simple to measure amplification of the Model 5000 Series Amplifier in terms of insertion gain. To do this, sample the input power to the amplifier by means of a flat 20 db directional coupler and compare the dual channel power output and power input displays or operate the instrument in the ratio mode and read the insertion gain directly. Gain should exceed 30 db across the full operating band.

b. If a conventional power meter is used for the output power measurement in paragraph 2.5.1 above, plot the output power and compare with the input power to obtain a direct indication of gain across the band. The gain should be greater than 30 db across the band.

5.5.3 SMALL-SIGNAL GAIN CHECK. Proceed as follows:

a. Adjust the rf signal generator and/or increase the amount of attenuation in the signal generator output line so that the incident power level applied to the amplifier RF IN connector is ≈ -20 dbm.

b. Make a power output/power input ratio measurement using the ALFRED 8000/7051 Sweep Network Analyzer, if available, to directly measure small-signal gain performance. The gain across the full frequency band of operation should be greater than 30 db.

c. If a Model 8000/7051 is not available, make power input and power output measurements, as necessary, following the procedure of paragraph 2.5.1 and 2.5.2 above, to evaluate the amplifier gain. The gain should exceed 30 db across the full operating frequency band.

5.5.4 SPURIOUS RF OUTPUT CHECK. To determine whether excessive spurious rf output and noise are being generated, proceed as follows:

a. Set up the Model 5000 for operation with ≈ 40 dbm rf output, in accordance with paragraph 5.5.1.

b. Connect the Model 5000 rf output through a 30 db attenuator pad to the rf input connector of a spectrum analyzer.

c. Set spectrum analyzer for 1 KHz IF bandwidth, 10 KHz RF bandwidth and 30 ms/cm sweep, and monitor the spurious output across the band. Nonharmonic spurious output should be at least 35 db below signal level throughout the band.

5.6 TROUBLESHOOTING.

5.6.1 STEPS TO FOLLOW WHEN FAILURE OCCURS. First check all low voltages and then all high voltages in accordance with paragraph 5.2 to help localize the trouble to a low voltage supply or to the TW tube or a high voltage supply/tube bias circuit.

CAUTION

If excessive voltages are being applied to the TW tube, disconnect its connections in accordance with the diagram given under paragraph 5.7.2 to avoid overdriving the TW tube while operating the Model 5000 to localize the trouble to particular components.

After making voltage measurements, refer to the appropriate one of the troubleshooting tables for individual supplies, if outputs are incorrect. If supplies are functioning properly, refer to the general troubleshooting table, Table 5-4, for assistance in locating the failed circuit and components. Before proceeding further, read the additional troubleshooting hints and cautions in the following paragraphs.

5.6.2 USE OF THE TROUBLESHOOTING TABLES. Tables 5-4 through 5-7 provide basic troubleshooting information for any Model 5000 series instrument. Table 5-4 is a general procedure which localizes gross performance faults to a particular circuit section. Tables 5-5 through 5-7 will be helpful to localize both failures and minor faults in individual power supplies and circuits.

5.6.3 LOCALIZATION OF TROUBLE TO INDIVIDUAL COMPONENTS. In addition to making in-circuit voltage measurements, it may be necessary to perform some active or passive circuit testing to pinpoint the defective component(s). In most cases, the performance of a particular transistor that is forward-biased can be evaluated by shorting the emitter and base lead where circuit voltages permit, or by opening the base lead. In either case, the transistor will be turned off unless it is shorted. Resultant changes in circuit voltages can be monitored to determine whether the transistor is performing. If a transistor does not conduct when its v_{be} exceeds cutoff - as can be determined by in-circuit measurements of its lead voltages (this may require

base-emitter shorting or base opening on other transistors to establish proper conditions) - it can be assumed to be open.

NOTE: The tab on all single transistors identifies the emitter lead. The tab on all dual transistors identifies the collector leads.

Another method of locating open or shorted transistors is by means of resistance measurements across the elements. Because of differences in transistors and ohmmeters, no specific information can be given about exact resistances. Generally, the ratio of forward and backward emitter-collector resistance is between 10:1 and 100:1, the ratio being lower for the higher-powered transistors. When a defective transistor is located, always look for another faulty element in the circuit which may have contributed to or resulted from the transistor failure.

Resistors and capacitors should be checked with one lead unsoldered to avoid any possibility of shunt paths and/or damage to transistors and diodes. Tubes V1 - V4 are best checked by substitution. If defective, they should all be replaced together.

CAUTION

1. USE OF OHMMETER. If an ohmmeter is used to check the forward and reverse resistance of transistors, or to make in-circuit resistance measurements in transistor circuits, check the ohmmeter voltage and current output on the range to be used before making any measurements. Many ohmmeters are unsuitable for use on certain ranges because they supply enough voltage or current to damage a transistor. Check both the open-circuit voltage and the short-circuit current, using suitable test instruments. Do not use any range where open-circuit voltage exceeds 1.5 V or short-circuit current exceeds 3 ma, because these levels may damage transistors.
2. MEASURING TRANSISTOR VOLTAGES. When checking to determine whether a particular transistor is forward-biased, measure the voltage on each lead independently with respect to ground. Do not attempt to measure v_{be} in one step by attaching the voltmeter directly to both leads, because transistor-damaging auxiliary currents may be established.
3. REMOVAL OF PC BOARDS. When a PC board is to be removed for component checking, observe the following precautions:
   a. Always turn the POWER button OFF before disconnecting any PC board. If this is not done, there is the possibility that some transistors will be burned out by transients that take place when the connection is made or broken.
   b. Be sure that the PC boards are installed with the component side facing the proper direction (not turned 180°) as shown in Figure 5-1. If the PC board is inadvertently turned 180°, extensive circuit damage may occur because of improper connections.

5.6.4 USE OF THEORY OF OPERATION. The detailed circuit theory given in Section 4 will be helpful in understanding circuit operation and locating possible causes of trouble. A good understanding of the circuit theory will enable a technician to analyze a particular indication of trouble in terms of faulty circuits or components to be checked out.

5.6.5 TWT AGING AND FAILURE. There are four general indicators of TW tube aging: (1) reduced rf output through the operating band; (2) complete loss of rf output at one or more frequencies in the operating band; (3) repeated trip-out of the high voltage due to recurring instances of helix overcurrent when operating with saturated output; (4) excess noise power output. Indications (1) and (2) above are usually caused by reduced cathode emission, while gas ionization of the TW tube causes indications (3) and (4). Faulty connections and internal TW tube damage can also cause any of these indications.

To localize trouble to the TW tube when indications of the above type are present, check all tube voltages and currents in accordance with paragraph 5.2 above, and make any necessary adjustments. If low rf output is the problem, try increasing the anode voltage slightly above the normal level to restore power output, before discarding the tube. If proper operation is not restored with proper voltages applied, and the TW tube is still in warranty, read the Tube Warranty and Replacement Procedure at the rear of this manual and follow the specified return procedure. If the tube warranty has expired, a replacement tube may be ordered from Alfred Electronics. The TW tube part number is given in the parts list, Section 6.

5.7 REPLACEMENT OF THE TW TUBE.

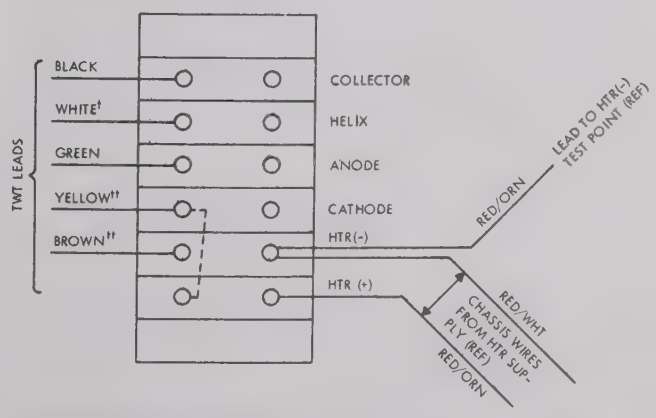
5.7.1 GENERAL. The TW tube is accessible for removal and replacement when the top cover is removed, as shown in Figure 5-1. The elapsed time meter (a fuse-like cartridge) is located on the center deck of the chassis just above the TW tube. After replacing the TW tube in accordance with the procedure of paragraph 5.7.2, follow the procedure of paragraph 5.7.3 to reset supply voltages as required by the new tube.

5.7.2 TW TUBE REPLACEMENT PROCEDURE.

a. See that the line cord is disconnected.

b. Remove the top and bottom cover plates by removing their attaching screws.

c. Disconnect the five tube leads from TB1 on the bottom side of the chassis. (These five leads pass through a hole in the chassis to the tube on the top side.) The diagram below locates the terminals used on TB1.



† Units in 1-2 GHz band have no helix lead.

†† On units S/N 251 & below, the CATHODE terminal was jumpered to the HTR(-) terminal at the factory, and the BRN lead connects to HTR(+). The BRN and YELLOW leads and the jumper should be changed to the configuration shown when the TW tube is replaced. The RED/ORN chassis lead to the HTR test point must also be switched to connect the test point to HTR -

d. Disconnect the RF input miniature coax cable from the type N connector rear the rear of the TW tube.

e. Remove the eight (8) bright-finish Phillips head screws which attach the TW tube to the chassis-mounted stand-off blocks.

CAUTION

Do not loosen the black hex-drive screws which are part of the TW tube.

f. Carefully move the TW tube slightly to the rear, so its RF output connector (which serves as the instrument RF OUT connector) will clear the front panel, and lift it out of the instrument.

g. Install the replacement tube by the reverse of the above procedure.

CAUTION

Be careful to observe connection configuration shown in step c above. On units S/N 251 and below, the instrument was not wired at the factory as shown in the diagram. When replacing the TW tube, change the jumper to connect between HTR + and CATH, with the yellow lead connected to CATH and the brown lead to HTR -. At the same time, the lead to the HTR test point (TP8) must be changed to connect to the HTR - connection on TB1, and the HTR + symbol should be changed to HTR - by scratching out the vertical bar of the +. The lead to the HTR test point is the red lead with orange stripes which passes through a chassis grommet with a harness of test point wires. Do not move the heater supply wire of the same color; refer to the wires labeled REF in the diagram above.

h. Check tube voltages in accordance with paragraph 5.7.3.

i. Replace the elapsed time meter M1 with a new cartridge.

5.7.3 ADJUSTMENT OF POWER SUPPLY VOLTAGES FOR THE REPLACEMENT TUBE. Normally, the resistors on PC board A6 will not have to be changed when a replacement tube is installed. The cathode supply adjustment A2R11 and the anode voltage adjustment A3R2 should provide sufficient range to properly set the voltages for the new tube. Refer to the data sheet supplied with the new tube to determine the proper cathode and anode (grid) voltages and the maximum cathode current and helix current, and set the voltages using the following procedure.

a. Set up for high voltage measurements and check cathode supply voltage as directed in steps a - h of paragraph 5.2.3.

b. Adjust the cathode supply voltage to the value specified on the new tube data sheet, in accordance with steps i and j of paragraph 5.2.3.

c. Check the anode supply voltage as directed in steps k - m of paragraph 5.2.3.

d. Adjust the anode supply voltage to the value specified on the new tube data sheet, in accordance with steps n and o of paragraph 5.2.3.

e. Measure collector and helix current by following the complete procedure of paragraph 5.2.4. If any measurement significantly exceeds the value shown on the tube data sheet, press the STANDBY button immediately and investigate the cause. If excessive electrode currents are drawn when the tube is installed and connected correctly, it is a possible indication of a damaged tube.

f. Place the new tube data sheet in the envelope at the rear of this manual for future reference.

g. Carry out a performance verification test in accordance with paragraph 5.5.

5.8 REPLACEMENT OF OTHER COMPONENTS.

5.8.1 REPLACEMENT OF PARTS ON PRINTED CIRCUIT BOARDS. Parts on all PC boards are identified by silkscreened reference designators. They are shown on the corresponding schematic diagram in Section 7. To remove individual components from PC boards, first make a diagram showing the exact orientation and connection of the part to simplify future installation. Use a low-power soldering iron (50 watts maximum) and apply heat sparingly to the lead of the part to be replaced. (The simplest way to remove a transistor is to cut its leads, and then unsolder the ends of the leads that are left in the board.) When removing the device leads, use a toothpick or a small awl to clear the holes of softened solder. Avoid excessive heat, and always ground the soldering iron to prevent leakage voltage from damaging the component.

When connecting the replacement component, trim the leads so they will penetrate the board about 1/16 inch with the component positioned about 3/16 inch above the board. Hold the part on the component side, and solder the leads from the other side. If possible, hold the component lead on the component side with a tool which will act as a heat sink, such as a pair of needle-nose pliers. Solder with the absolute minimum of heat necessary to completely melt the solder, to avoid overheating. Use a high-quality rosin core solder only; never use paste flux. After soldering, trim off excess leads and flux.

If a break occurs in the etched copper circuit, repair it by soldering a short length of tinned copper wire across the break. Copper that lifts off the board should be cemented in place with a quick-drying acetate base cement having good electrical insulating properties.

5.8.2 REPLACEMENT OF CHASSIS-MOUNTED PARTS. Most parts mounted directly on the chassis or on terminal boards are identified by silkscreened reference designators. Parts not so identified are called out in Figures 5-1 and 5-2 for easy reference. These parts are all shown on the overall schematic diagram, D900842, in Section 7. For soldering work, a 50-watt soldering iron and high-quality rosin core solder should be used. Avoid overheating, and use a pair of needle-nose pliers as a heat sink on the component end of the lead as an extra precaution.

5.8.3 ADJUSTMENTS REQUIRED AFTER PARTS REPLACEMENT. After replacing any rectifiers on terminal board A5 or compon-

ents on PC board A1, check and adjust the -40 V dc supply in accordance with steps a - e of paragraph 5.2.2. After replacing any component in the high voltage rectifier/voltage doubler circuit on the chassis, or in the regulator amplifier portion of PC board A2, or on PC board A6, check and adjust the cathode supply and anode voltages in accordance with paragraph 5.2.3. After replacing any component on the heater supply platform assembly A3 or the heater regulator PC board A4, check and adjust the heater supply voltage in accordance with steps a - d and j - n of paragraph 5.2.2. Also check (and adjust, if necessary) the heater supply overvoltage, overcurrent, and undervoltage protection circuits in accordance with paragraphs 5.3.2 and 5.3.3. After replacing any component in the high voltage protection circuit portion of PC board A2, check the heater undervoltage and helix overcurrent protection circuits in accordance with paragraphs 5.3.3 and 5.3.4.

Tables 5-4 thru 5-7

and

Figures 5-1 thru 5-5

Follow This Page

Table 5-4. Trouble-Shooting Chart for the Model 5000

Trouble (Indication)	Probable Cause	Remedy
1. NO PRIMARY POWER. (POWER ON light DS1 does not come on inside POWER pushbutton when pressed.)	a. Line cord not connected to live circuit.	a. Check receptacle voltage.
	b. Main fuse F1 blown.	b. Check the primary control circuits for a short or a faulty component. Check S1, S2, T2, F1 and replace as necessary.
	c. POWER ON light burned out.	c. Check DS1 and replace if necessary.
	d. Fault in HV supply causing overload.	d. Check HV rectifier/voltage doubler components T1, CR11 - CR14, C3, C4, C5, V1 - V4, and replace if necessary.
2. NO HIGH VOLTAGE POWER. (STANDBY light does not come on after primary power has been on for about 90 seconds.)	a. STANDBY light burned out.	a. Check DS2 and replace if necessary.
	b. Fault detected by Standby Mode Protection Circuit interlocks (See Figure 4-4).	b. Check that both top and bottom cover plates are properly installed, that all PC boards are properly inserted, that the blower is operating properly, and that the air filter is not clogged.
	c. Defective relay K1 or K2.	c. Check K1 and K2 and replace as necessary.
	d. Defective primary connections to transformer T1 through switch S2.	d. Check primary connections to T1 and S2.
3. Instrument entered STANDBY mode but will not go into OPERATE mode. (OPERATE light does not come on, and STANDBY light stays lit, when OPERATE button is pressed.)	a. OPERATE light burned out.	a. Check DS3 and replace if necessary.
	b. Fault detected by Operate Mode High Voltage Protection Circuits (See Figure 4-5).	b. Check that heater voltage is correct. (See paragraph 5.2.2 and Table 5-6.)
	c. Defective relay K4.	c. Check K4 and replace if necessary.
	d. Defective relay K3.	d. Check K3, and replace if necessary.
	e. Defective relay A3K5.	e. Check A3K5 and replace if necessary.
	f. Defective A3DSR1.	f. Make voltage measurements at A3DSR1 (See Figure 4-5 and schematic D900842.) If a negative voltage of -30 V or more is not coupled out to J4-E through the light-sensitive resistor when proper heater voltage is being supplied, replace A3DSR1.
	g. TW Tube draws excess helix current.	g. Disconnect TW Tube leads from TB1. Then see whether HV comes on. Refer to paragraph 5.3. for checkout and adjustment of A2R15. If the TW Tube draws excess helix current, it must be replaced (see paragraph 5.7).
4. Instrument entered OPERATE Mode, but suddenly reverts to STANDBY Mode. (OPERATE light goes out and STANDBY light comes on without the STANDBY button being pressed.)	a. Tripout due to heater supply malfunction.	a. Check that heater voltage is correct. (See paragraph 5.2.2 and Table 5-6.)
	b. TW Tube draws excess helix current.	b. Attempt to operate unit with no rf input signal. If unit trips out only when driven to output saturation, it is probable that helix tripout is the cause. Refer to paragraph 5.3. for checkout and adjustment of A2R15. If the TW Tube draws excess helix current, it must be replaced (see paragraph 5.7).
	c. Failure of relay K3, K4, or A3K5.	c. Check K3, K4, and A3K5 and replace as necessary.
	d. Failure of regulator tubes V1 - V4 (due to arc-over).	d. Check V1 - V4 by substitution. Replace all 4 as a group if replacement is necessary.

Table 5-4. Trouble-Shooting Chart for the Model 5000 (Cont'd)

Trouble (Indication)	Probable Cause	Remedy
5. Instrument entered STANDBY and/or OPERATE mode, but suddenly reverts to Power On Mode. (Both STANDBY and OPERATE lights go out.)	a. Fault detected by Standby Mode Protection Circuit interlocks (See Figure 4-4).	a. Check that both top and bottom cover plates are properly installed, that all PC boards are properly inserted, that the blower is operating properly, and that the air filter is not clogged.
6. Instrument does not provide 30 db gain or + 40 dbm RF power output in OPERATE mode.	a. Improper low-voltage or high-voltage supply outputs.	a. Check all supplies and TW Tube operating voltages in accordance with paragraph 5.2. Make any necessary repairs or adjustments to establish in-spec voltages.
	b. Defective TW Tube.	b. If TW Tube does not provide suitable rf output power or gain with proper voltages applied, try increasing the anode voltage slightly to restore performance. If this does not restore performance, replace the TW Tube (see paragraph 5.7).
7. Instrument rf output contains excessive spurious signals and noise.	a. Excess ripple on one or more supplies.	a. Check ripple on all supplies. Make any necessary repairs (parts replacement) to reduce ripple to in-spec levels.
	b. Noisy input signal.	b. Check that input signal does not contain excessive noise components.
	c. Defective TW Tube.	c. If TW Tube output contains excess noise when such noise is not present on the rf input signal, and when all tube operating voltages are free of excess ripple, replace the TW Tube (see paragraph 5.7).
8. Instrument entered OPERATE mode but will not revert to STANDBY Mode. (OPERATE light remains on when STANDBY button is pressed.)	a. Shorted A2Q5.	a. Check A2Q5 and replace if necessary.
9. Instrument does not provide proper output after new TW Tube is installed.	a. Improper TW Tube connections.	a. Carefully check TW Tube connections with the diagram given in paragraph 5.7.2.
	b. Improper low-voltage or high-voltage supply outputs.	b. Check all supplies and TW Tube operating voltages against the requirements of the new tube. Make any necessary adjustments to establish proper voltages.
	c. Defective regulator tubes V1 - V4.	c. Replace V1 - V4 as a group.
	d. Defective TW Tube.	d. Contact factory for guidance before replacing TW Tube.

Table 5 -5. Trouble Shooting the Low Voltage Supplies

Trouble Indication	Suggested Cause and Remedy
1. -40 V output is outside the -40.00 ± .01 V range.	Check adjustment of A1R8 following the procedure of paragraph 4.2.2, steps a - f.
2. -40 V output connot be adjusted to the proper voltage.	a. Check for defective regulator transistor A1Q2. Replace if necessary. b. Check for defective rectifier components A5CR9 - A5CR12 and C9 and replace as necessary. c. Check for defective reference circuit components A1C6, A1R18, A1CR4, and A1C2, and replace as necessary. d. Check for defective regulator amplifier/driver components A1CR3, A1Q8, A1Q9, A1Q1 and associated components, and replace as necessary. e. Check for burned-out component or other condition producing overload on -40 V supply output. Repair or replace as necessary.
3. +20 V output is outside the +20.0 V ±1.0 V range.	a. Check that -40 V supply is properly set to -40.00 ± .01 V. b. Check for defective regulator transistor A1Q5. Replace if necessary. c. Check for defective rectifier components A5CR5 - A5CR8 and C8, and replace as necessary. d. Check for defective reference circuits components A1Q6, A1Q7, A1C1, A1C5, and associated parts, and replace as necessary. e. Check for defective regulator amplifier/driver components A1Q3 or A1Q4 or associated parts, and replace as necessary. f. Check for burned-out component or other condition producing overload on +20 V supply output. Repair or replace as necessary.
4. Excessive ripple on -40 V or +20 V supply.	a. Check for defective filter capacitors C8 or C9, and replace as necessary. b. Check for noisy zener diode A1CR4, and replace if necessary. c. Check for defective capacitor(s) on A1 PC board. Replace as necessary.

Table 5-6. Trouble Shooting the Heater Supply and Protection Circuits.

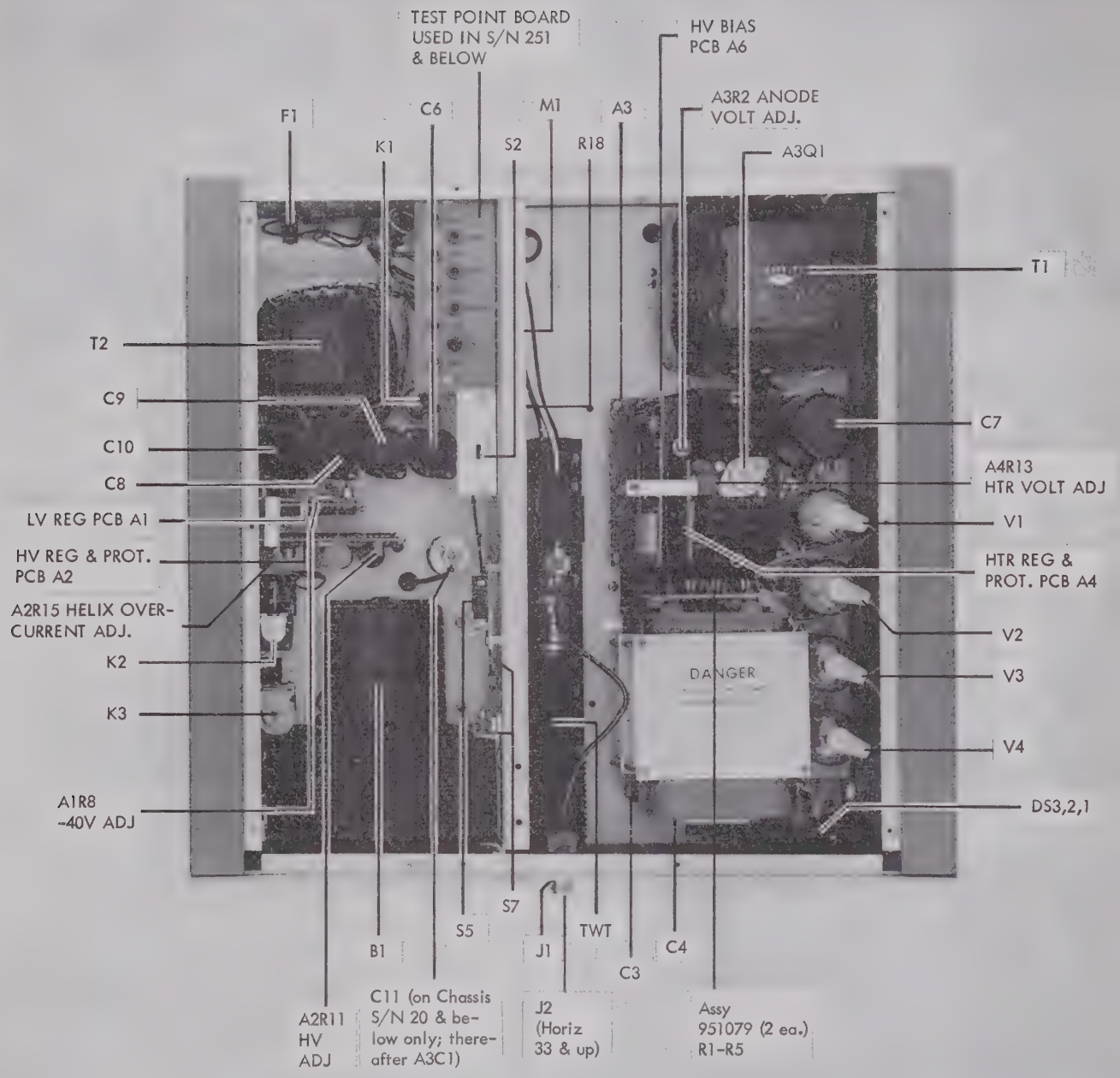
Trouble Indication	Suggested Cause and Remedy
1. Heater supply protection circuits produce high- voltage trip-out.	a. Disable high voltage by removing the top cover without defeating the interlock switch. Then check the voltage developed by the heater supply, between J5-E (+) and J5-L (-). If the voltage is not 6.3 V, attempt to adjust it to 6.3 V using A4R13. b. If trip-out occurs with the voltage properly set at 6.3 V, it may be due to a heater over current condition. Disconnect the TW Tube yellow lead from the CATH terminal on TB1 and measure the resistance between the TW Tube brown and yellow wire leads. Resistance should be 6.3 Ω ±10%. If the resistance is outside this range, the TW Tube is probably defective and should be replaced. c. If trip-out occurs with the voltage properly set at 6.3 V, and the TW Tube resistance is correct, one of the protection circuits may be at fault. Check A3DS1, A3K5, A4Q6, A4Q7, A4Q8, A4Q9, A4Q1, A4Q2, and associated components, and replace as necessary.
2. Heater voltage connot be properly set to 6.3 V ±0.2 V using A4R13.	a. Check regulator transistor A3Q1, and replace if necessary. b. Check for defective rectifier components A3CR1, A3CR2, A3C7, or filter capacitor A4C2, and replace as necessary. c. Check for defective reference circuit components A4Q5, A4CR4, or A4C1 (if present) or associated parts, and replace as necessary. d. Check for defective regulator amplifier/driver circuit components A4Q3 or A4Q4 or associated parts, and replace as necessary.
3. Excessive ripple on heater supply.	a. Check for defective capacitors C7 or A4C2, and replace as necessary. b. Check for defective zener reference diode A4CR4, and replace if necessary. c. Try adding optional capacitor A4C1 (See schematic C900911).
4. Low voltage condition does not produce trip-out.	a. Check A4Q8, A4Q9, A4CR2, A4Q1, A3DSR1, and associated components, and replace if necessary. b. Calibrate the low voltage trip-out point by changing the value of A4R17 in accordance with paragraph 5.3.3, steps a - g.
5. Overvoltage condition does not produce trip-out.	a. Check A4Q6, A4Q7, A4CR2, A3K5, and associated components, and replace if necessary. b. Calibrate the high voltage trip-out point by changing the value of A4R18 in accordance with paragraph 5.3.2, steps a - c.
6. Overcurrent condition does not produce trip-out.	a. Check value of A3R1, which should be 0.27 Ω. Replace if necessary. b. Check A4Q2, A4Q4 and associated components, and replace as necessary.

Table 5-7. Trouble Shooting the High Voltage Supplies

Trouble Indication	Suggested Cause and Remedy
1. High voltage arc-over is heard within instrument.	a. Replace V1 - V4 as a group. b. Check turn-on offset driver Q2, CR18, and associated components, and replace as necessary. c. Determine whether cathode supply voltage can be set to the specified value by adjustment of A2R11 if the secondary output of transformer T1 is connected to next lower-numbered terminal, to reduce the drop required across V1 - V4.
2. Cathode supply output voltage is incorrect.	Adjust the supply output using A2R11 in accordance with the procedure of paragraph 5.2.3, steps a - i.
3. Cathode supply output voltage cannot be set to the required value; supply does not respond significantly to adjustment of A2R11.	a. Check for proper +20 V and -40 V supply outputs. b. Check the feedback resistor string including A6R1 - A6R7, R21, and R10, and replace as necessary. c. Check the rectifier/voltage doubler circuit including CR11 - CR14, C1 - C5, R1 - R5 on each assembly 951079, and associated components, and replace as necessary. d. Check the reference circuit, including A2Q3, A2Q4, A2CR1, A2CR2, A2C4, A2C5, and associated components, and replace as necessary. e. Check the regulator amplifier/driver circuit, including A2Q1, A2Q2, A2C2 and associated components, and replace as necessary. f. Check capacitor A3C1 and replace if leaky. g. Check V1 - V4 and associated biasing resistors. Replace V1 - V4 as a group if necessary.
4. Cathode supply output voltage cannot be set to the required value; supply does respond to adjustment of A2R11 but does not offer sufficient range.	a. Check V1 - V4 and associated biasing resistors. Replace V1 - V4 as a group if necessary. b. Check for proper resistance values in the feedback resistor string including A6R1 - A6R7, R21, and R10, and replace as necessary. c. Check the rectifier/voltage doubler circuit including CR11 - CR14, C1 - C5, R1 - R5 on each assembly 951079, and associated components, and replace as necessary. d. Check capacitor A3C1 and replace if leaky. e. Check the regulator amplifier/driver circuit, including A2Q1, A2Q2, A2C2 and associated components, and replace as necessary. f. Check the reference circuit, including A2Q3, A2Q4, A2CR1, A2CR2, A2C4, A2C5, and associated components, and replace as necessary. g. Compare the secondary output connection from T1 to the voltage doubler with the "typical" terminals used for each model as shown on schematic D900842. The higher the tap number, the higher the voltage. The red/black wire connecting the rectifier/doubler diodes to tap #5 should not be moved. The red wire which connects to the 951079 boards may be moved 1 tap if necessary to improve output voltage control.

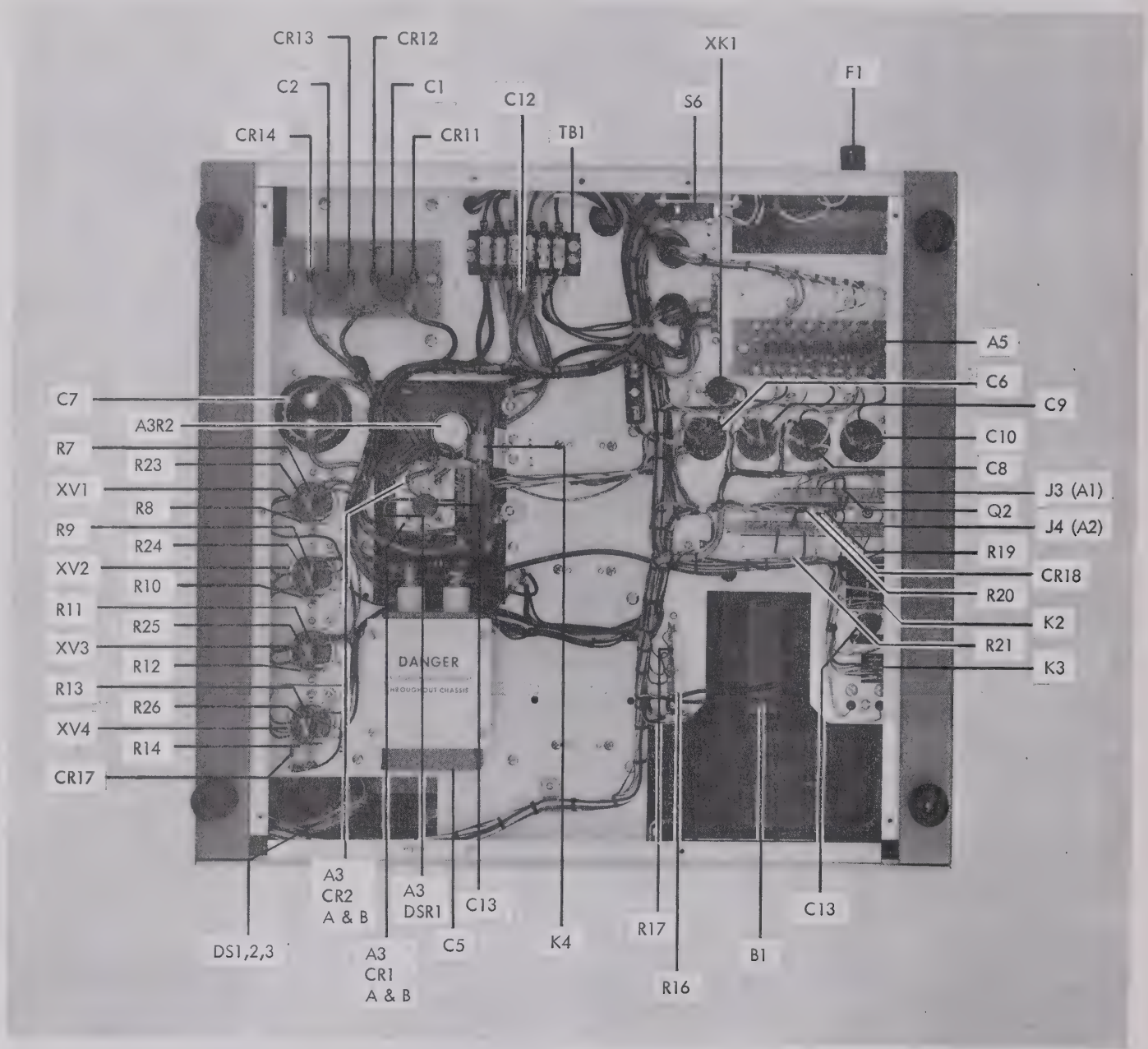
Table 5-7. Trouble Shooting the High Voltage Supplies (Cont'd)

Trouble Indication	Suggested Cause and Remedy
5. High voltage trip-out occurs when heater voltage is proper and TW Tube is note drawing excessive helix current.	a. Check A3DSR1 and replace if necessary. b. Check A2Q5, A2Q6, A2Q7, A2CR3, A2CR4 and associated components, and replace as necessary.
6. Excessive ripple on cathode supply.	a. Check C6 and replace if necessary. b. Check C5 and replace if necessary. c. Check A3C1 and replace if necessary. d. Check C13 and replace if necessary.
7. Anode supply voltage cannot be set to the required value using A3R2 when the cathode supply output voltage is correct.	a. Check for proper resistance values in the anode dropping resistor string including A6R8 - A6R16 and replace as necessary. b. Check for defective A6CR1 and replace if necessary.



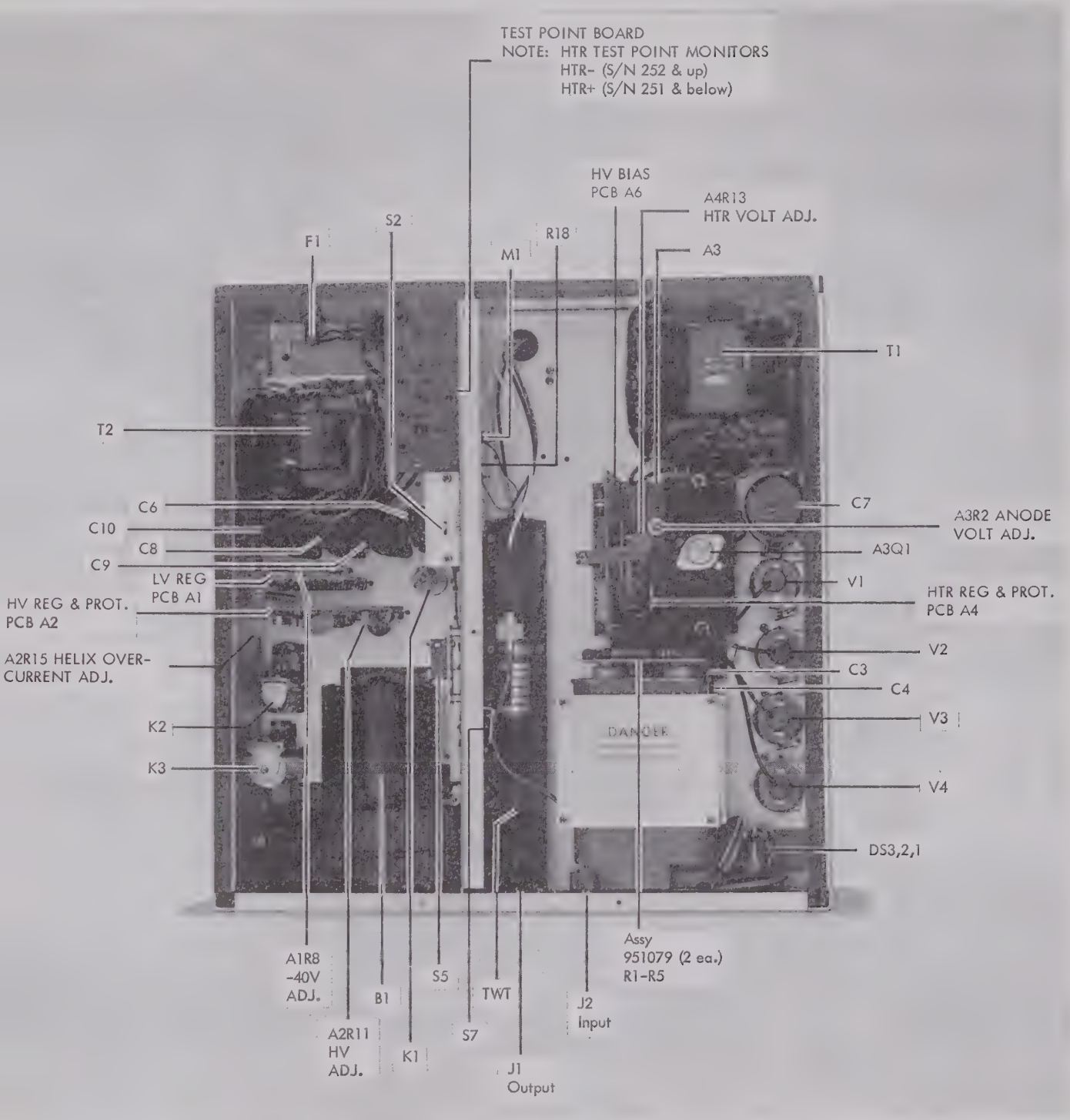
A. Early Production Units

FIGURE 5-1. TOP VIEW OF MODEL 5000 (SHEET 1 OF 2)



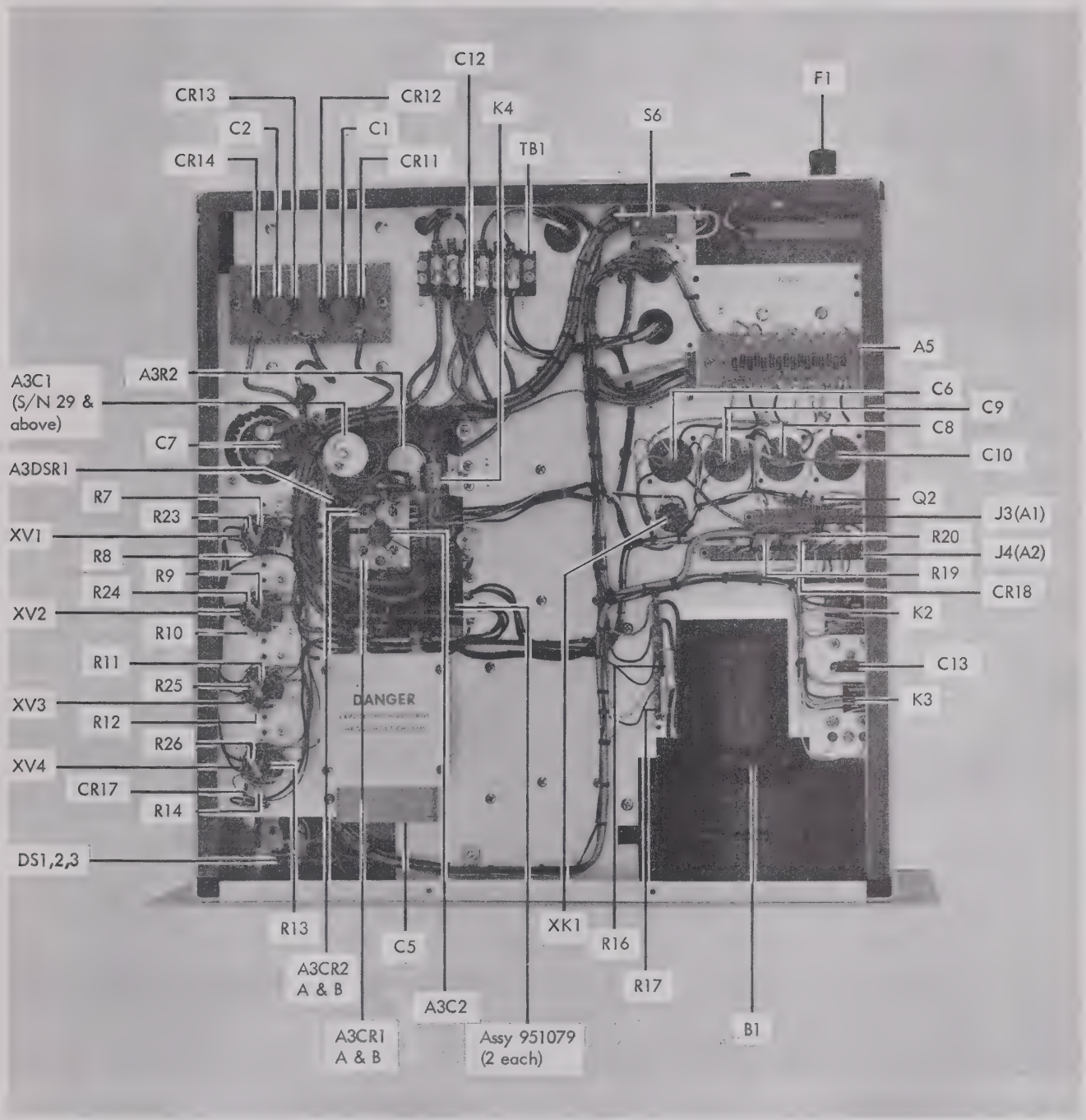
A. Early Production Units

FIGURE 5-2. BOTTOM VIEW OF MODEL 5000 (SHEET 1 OF 2)



B. Recent Production Units

FIGURE 5-1. TOP VIEW OF MODEL 5000 (SHEET 2 OF 2)



B. Recent Production Units

FIGURE 5-2. BOTTOM VIEW OF MODEL 5000 (SHEET 2 OF 2)

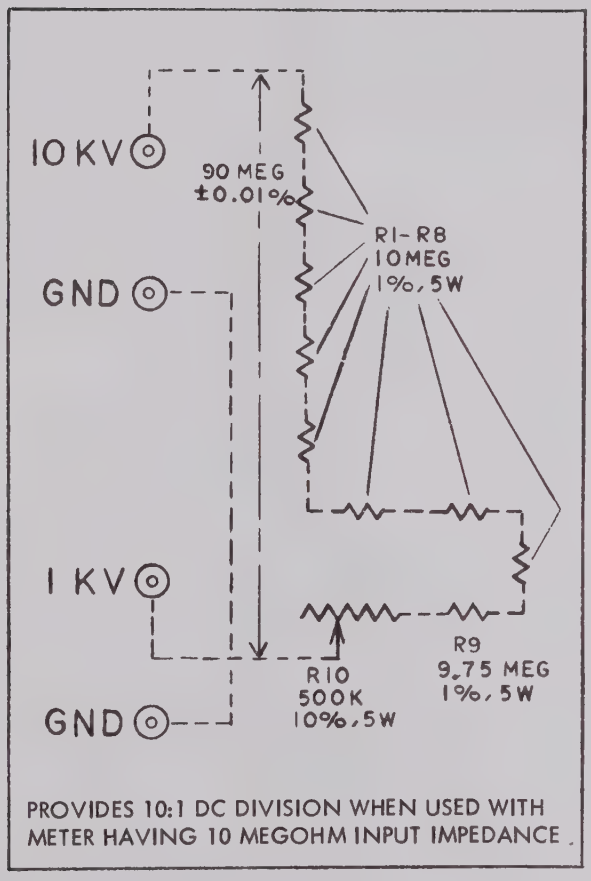


FIGURE 5-3. DC DIVIDER BOX

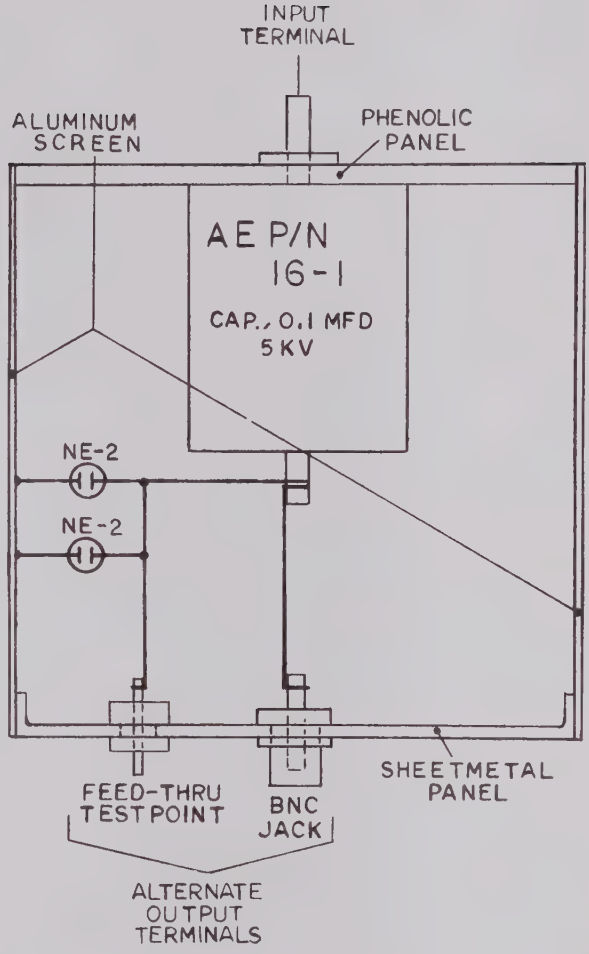


FIGURE 5-4. CAPACITIVE ISOLATION BOX

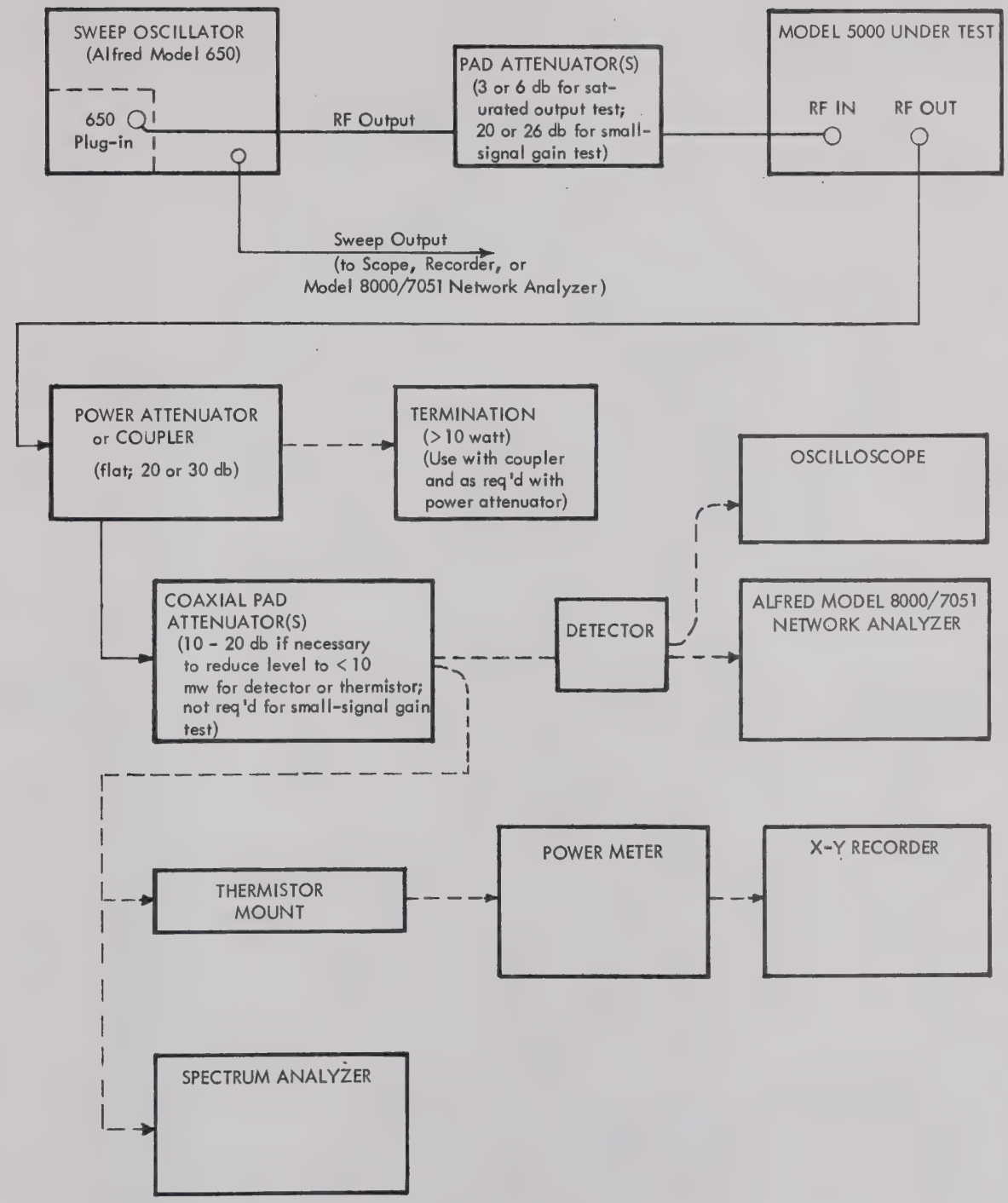


FIGURE 5-5. RF PERFORMANCE TEST CONNECTIONS

SECTION 6

PARTS LIST

LIST OF ASSEMBLIES

Circuit Reference	Alfred Part No.	Description	Schematic
		Main Chassis	D900842
A1	951005	Low Voltage Regulator PC Board A1	C900912
A2	951014	High Voltage Regulator PC Board A2	C900913
A3	951007	Heater Supply Platform Assy. A3	D900842 **
A4	951006	Heater Regulator PC Board A4	C900911
A5	951015	Low Voltage Rectifier Assy. A5	D900842 **
A6	951009	Model 5010 High Voltage Bias PC Board A6	B900914†
	951011	Model 5020 High Voltage Bias PC Board A6	B900914†
	951012	Model 5030 High Volatge Bias PC Board A6	B900914†
	951013	Model 5040 High Voltage Bias PC Board A6	B900914†

**Part of schematic listed
†Printed on apron of D900842

MAIN CHASSIS

MODEL 5000 MAIN CHASSIS

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION	TRUE MFR. FSC NO.	TRUE MFR. PART NO.
		BLOWER		
B1	951377	Fan/housing	03782	951377
		CAPACITORS		
C1 and C2	12-38	Fixed, ceramic, .0022 µf, 6Kv	71590	DD60-222
C3 and C4	15-12	Fixed, oil, 4 µf, 2.5Kv 10%	00853	702012-5703
C5	15-22	Fixed, paper, 1 µf, 4Kv	99120	LK40-105
C6 A & B	13-54	Fixed, dual elect., 50/80 uf, 150v	56289	TVL 2442.1
C7	13-25	Fixed, elect., 4 µf, 2.5Kv, 10%	00853	702012-5703
C8 A & B	13-36	Fixed, dual elect., 100 µ f, 50 v/ 100 µf, 50 v	56289	TVL 2326
C9 A & B	13-46	Fixed, dual elect., 100 µf, 50 v/ 150 µf, 150 v	56289	TVL 2413
C10 A & B	13-36	Fixed, dual elect., 100 µf, 50 v/ 100 µf, 50 v	56289	TVL 2326
C11		Not used		
C12	12-33	Fixed, ceramic, .01 µf, 3Kv	56289	30GA-S10
C13	12-2	Fixed, ceramic, .001 µf, 1Kv	91418	JL-X5R-.001
		DIODES		
CR1 thru CR4		Not used		
CR5	81-20	1N4385/DI-46	76433	1N4385
CR6 thru CR10		Not used		
CR11 thru CR14	81-135	MR 995A/EH400	04713	MR 995A
CR15 and CR16		Not used		
CR17	(81-20)	Same as CR5	(76433)	(1N4385)
CR18	81-41	1N459	07263	1N459

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION	TRUE MFR. FSC NO.	TRUE MFR. PART NO.
		INDICATORS		
DS1 thru DS3	126-14	Type 327	08806	#327
		FUSES		
F1	121-4	Type 3AG, slo-blo, 4 amps, 125 v (for Models 5010, 5020, & 5030)	75915	312004
	121-5	Type 3AG, slo-blo, 5 amps, 125 v (for Model 5040)	75915	312005
		CONNECTORS, Jacks		
J1		Type N (RF OUT - part of TWT)		
J2	950356	Type N (RF IN)	03782	950356
J3	133-64	PC Board, 15 pin (A1)	81312	KZ15S
J4	133-63	PC Board, 22 pin (A2)	81312	KZ22S
J5 and J6		Not used		
		RELAYS		
K1	106-27	Time delay, 90 sec.	70563	6N090T
K2	106-33	6 VAC, 4 pole, DT	04773	PE 2473-D11
K3*	106-34	12 V, 750 Ω, DPDT	04773	PR 819-87
K4*	106-23	High voltage, encapsulated	18741	H/7/S1
		METERS		
M1	87-3	Elapsed time	03782	87-3
		TRANSISTORS		
Q1		Not used		
Q2	81-72	2N699	96214	2N699

* 26V relay is used in S/N 31 and below.

MAIN CHASSIS (Con'd)

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION	TRUE MFR. FSC NO.	TRUE MFR. PART NO.
		RESISTORS		
R1 ** thru R5 **	43-150K	Fixed, comp., 150K, 2 w, 10%	01121	HB 1541
** R1 thru R5 are located on Assy. 951079. There are two identical 951079 Assemblies in the instrument each containing one set of resistors R1 thru R5.				
R6		Not used		
R7	51-1K	Fixed, carb. film, 1K, 1/2 w, 5%	73445	E-009-AB/B-1K
R8	51-47 Ω	Fixed, carb. film, 47 Ω, 1/2 w, 5%	73445	E-009-AB/B-47 Ω
R9	(51-1K)	Same as R7	(73445)	(E-009-AB/B-1K)
R10	(51-47 Ω)	Same as R8	(73445)	(E-009-AB/B-47 Ω)
R11	(51-1K)	Same as R7	(73445)	(E-009-AB/B-1K)
R12	(51-47 Ω)	Same as R8	(73445)	(E-009-AB/B-47 Ω)
R13	(51-1K)	Same as R7	(73445)	(E-009-AB/B-1K)
R14	(51-47 Ω)	Same as R8	(73445)	(E-009-AB/B-47 Ω)
R15		Not used		
R16 and R17	61-13	Fixed, WW, 2.5K, 5 w	44655	4633
R18	56-18.7K	Fixed, met. film, 18.7K, 1/2 w, 1%	19701	MF-7C-TO-18.7K
R19	51-5.6K	Fixed, carb. film, 5.6K, 1/2 w, 5%	73445	E-009-AB/B-5.6K
R20	51-56K	Fixed, carb. film, 56K, 1/2 w, 5%	73445	E-009-AB/B-56K
R21	56-45.3K	Fixed, met. film, 45.3K, 1/2 w, 1%	19701	MF-7C-TO-45.3K
R22		Not used		
R23 thru R26	51-3.9K	Fixed, met. film, 3.9K, 1/2 w, 5%	73445	E-009-AB/B-3.9K
		SWITCHES		
S1	101-27	Pushbutton (B990199)	03782	B990199
S2	102-128	Lever	76854	233-785-187-N1
S3	101-26	Pushbutton (B990199- 1)	03782	B990199-1
S4	101-25	Pushbutton (B990199- 2)	03782	B990199-2
S5 and S6	101-17	Interlock, high voltage	01963	E18-00M
S7	101-22	Interlock, vane activated	03782	91-204
		TRANSFORMERS		
T1	91-203	C950823	03782	950823
T2	91-204	C950822	03782	950822
		TUBES, Vacuum		
V1 thru V4	111-8068	8068	33173	8068
		TUBES, Traveling Wave		
V-TWT	112-064	1 - 2 GHz (Model 5010) L5036	03782	112-064
	112-062	2 - 4 GHz (Model 5020) L5019	03782	112-062
	112-063	4 - 8 GHz (Model 5030) L5011	03782	112-063
	112-061	7 - 11 GHz (Model 5040) L3928	03782	112-061
		HOLDERS, Fuse		
XF1	122-1	Panel mount, type 3 AG	75915	342004
		SOCKETS, Relay		
XK1	136-19	9 pin, mini.	95354	S161-125-PB
		HOLDERS, Meter		
XM1	122-2	Snap-in, type 3AG	75915	357001
		SOCKETS, Tube		
XV1 thru XV4	136-20	Octal	71785	8EM
		CORDS, Electrical		
W1	142-4	3 wire, 6 ft.	70903	17237B

A1 LOW VOLTAGE REGULATOR PC BOARD 951005

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION	TRUE MFR. FSC NO.	TRUE MFR. PART NO.
		CAPACITORS		
A1C1 and A1C2	13-40	Fixed, elect. 5 μf, 50 v	56289	TE 1303
A1C3 and A1C4	12-13	Fixed, ceramic, .005 μf, 500 v	71982	811-Z5V-502P
A1C5 and A1C6	(13-44)	Same as A4C1	(56289)	(TE 1303)
		DIODES		
A1CR1 thru A1CR3	81-41	1N459	07263	1N459
A1CR4	81-75	1N823, 6.2 v	04713	1N823
		TRANSISTORS		
A1Q1	81-115	2N3565	07263	2N3565
A1Q2	81-72	2N699	96214	2N699
A1Q3	81729	2N3645	07263	2N3645
A1Q4	(81-115)	Same as A1Q1	(07263)	(2N3565)
A1Q5	81-71	2N697	96214	2N697
A1Q6 thru A1Q9	(81-115)	Same as A1Q1	(07263)	(2N3565)
		RESISTORS		
A1R1	51-68K	Fixed, carb. film, 68K, 1/2 w, 5%	73445	E-009-AB/B-68K
A1R2	51-1.8K	Fixed, carb. film, 1.8K, 1/2 w, 5%	73445	E-009-AB/B-1.8K
A1R3	51-47 Ω	Fixed, carb. film, 47 Ω, 1/2 w, 5%	73445	E-009-AB/B-47 Ω
A1R4	51-10K	Fixed, carb. film, 10K, 1/2 w, 5%	73445	E-009-AB/B-10 Ω
A1R5 and A1R6	(57-47 Ω)	Same as A1R3	(73445)	(E-009-AB/B-47 Ω)
A1R7	56-1.21K	Fixed, met. film, 1.2K, 1/2 w, 1%	19701	MF-7C-TO-1.21K
A1R8	71-90	Variable, comp., 200 Ω, 3/4 w	21030	79PR200
A1R9	56-6.81K	Fixed, met. film, 6.81K, 1/2 w, 1%	19701	MF-7C-TO-6.8K
A1R10	56-3.48K	Fixed, met. film, 3.48K, 1/2 w, 1%	19701	MF-7C-TO-3.48K
A1R11 and A1R12	51-100 Ω	Fixed, carb. film, 100 Ω, 1/2 w, 5%	73445	E-009-AB/B-100 Ω
A1R13	51-180K	Fixed, carb. film, 180K, 1/2 w, 5%	73445	E-009-AB/B-180K
A1R14 and A1R15	51-330K	Fixed, carb. film, 330K, 1/2 w, 5%	73445	E-009-AB/B-330K
A1R16	56-4.99K	Fixed, met. film, 4.99K, 1/2 w, 1%	19701	MF-7C-TO-4.99K
A1R17	56-10K	Fixed, met. film, 10K, 1/2 w, 1%	19701	MF-7C-TO-10K
A1R18	56-1.05K	Fixed, met. film, 1.05K, 1/2 w, 1%	19701	MF-7C-TO-1.05K
A1R19	51-6.8K	Fixed, carb. film, 6.8K, 1/2 w, 5%	73445	E-009-AB/B-6.8K
A1R20	56-6.81K	Fixed, met. film, 6.81K, 1/2 w, 5%	19701	MF-7C-TO-6.81K

A2 HIGH VOLTAGE REGULATOR PC BOARD 951014

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION	TRUE MFR. FSC NO.	TRUE MFR. PART NO.
		CAPACITORS		
A2C1 thru				
A2C3	12-34	Fixed, ceramic, 0.1 µf, 100 v	91418	BT 010
A2C4	13-44	Fixed, elect., 5 µf, 50 v	56289	TE 1303
A2C5	(12-34)	Same as A2C1	(91418)	(BT 010)
		DIODES		
A2CR1 thru				
A2CR3	81-20	1N4385/DI-46	76433	1N4385
A2CR4	81-41	1N459	07263	1N459
		TRANSISTORS		
A2Q1 and				
A2Q2 and	81-129	2N3645	07263	2N3645
A2Q3 and				
A2Q4	81-115	2N3565	07263	2N3565
A2Q5	81-137	2N3568 (S/N 32 & above)	07263	2N3568
	81-72	2N699 (S/N 31 & below)	96214	2N699
A2Q6	81-72	2N699	96214	2N699
A2Q7	81-71	2N697	96214	2N697
		RESISTORS		
A2R1	43-1K	Fixed, comp., 1K, 2 w, 10% (S/N 32 & above)	01121	HB 1021
	43-5.6K	Fixed, comp., 5.6K, 2 w, 10% (S/N 31 & below)	01121	HB 5621
A2R2	42-56K	Fixed, comp., 56K, 1 w, 10% (S/N 32 & above)	01121	GB 5631
	43-22K	Fixed, comp., 22K, 2 w, 10% (S/N 31 & below)	01121	HB 2231
A2R3	51-3.9K	Fixed, carb. film, 3.9K, 1/2 w, 5%	73445	E-009-AB/B-3.9K
A2R4	51-10K	Fixed, carb. film, 10K, 1/2 w, 5%	73445	E-009-AB/B-10K
A2R5	51-1.5K	Fixed, carb. film, 1.5K, 1/2 w, 5%	73445	E-009-AB/B-1.5K
A2R6	56-18.7K	Fixed, met. film, 18.7K, 1/2 w, 1%	19701	MF-7C-TO-18.7K
A2R7	42-68 Ω	Fixed, comp., 68 Ω, 1 w, 10%	01111	GB 6801
A2R8	51-180K	Fixed, carb. film, 180K, 1/2 w, 5%	73445	E-009-AB/B-180K
A2R9	51-5.6K	Fixed, carb. film, 5.6K, 1/2 w, 5%	73445	E-009-AB/B-5.6K
A2R10	56-16.2K	Fixed, met. film, 16.2K, 1/2 w, 5%	73445	E-009-AB/B-16.2K
A2R11	71-94	Variable, comp., 5K, 3/4 w,	21030	79PR5K
A2R12	51-1.8K	Fixed, carb. film, 1.8K, 1/2 w, 5%	73445	E-009-AB/B-1.8K
A2R13	51-11K	Fixed, carb. film, 11K, 1/2 w, 5% (S/N 32 & above)	73445	E-009-AB/B-27K
	51-27K	Fixed, carb. film, 27K, 1/2 w, 5% (S/N 31 & below)	73445	E-009-AB/B-27K
A2R14	51-6.8K	Fixed, carb. film, 6.8K, 1/2 w, 5%	73445	E-009-AB/B-6.8K
A2R15	71-106	Variable, comp., 5K, 1/8 w, 30%	71450	XHT-201-5K
A2R14	51-6.8K	Fixed, carb. film, 6.8K, 1/2 w, 5%	73445	E-009-AB/B-6.8K
A2R15	71-106	Variable, comp., 5K, 1/8 w, 30%	71450	XHT-201-5K
A2R16	51-20K	Fixed, carb. film, 20K, 1/2 w, 5% (S/N 32 & above)	73445	E-009-AB/B-20K
	51-47K	Fixed, carb. film, 47K, 1/2 w, 5% (S/N 31 & below)	73445	E-009-AB/B-47K
A2R17	51-47K	Fixed, carb. film, 47K, 1/2 w, 5%	73445	E-009-AB/B-47K

A3 HEATER SUPPLY PLATFORM ASSY. 951007

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION	TRUE MFR. FSC NO.	TRUE MFR. PART NO.
		CAPACITORS		
A3C1	16-7	Fixed, plastic, .1 µf, 4Kv	99120	OF-40-104
A3C2	12-9	Fixed, ceramic, .05 µf, 75 v, 20%	71590	DDA-503
		DIODES		
A3CR1				
A & B	81-82	MR 322	04713	MR 322
A3CR2				
A & B	81-93	MR 322R	04713	MR 322R
A3CR3	81-20	1N4385	76433	1N4385
		PHOTOCELLS		
DSR1	951044	Photocell assembly	03782	951044
		RELAYS		
A3K1 thru				
A3K4		Not used		
A3K5	106-29	335 Ω, R55D	77342	RS5K-6VDC
		CONNECTORS		
A3J1 thru				
A3J4		Not used		
A3J5	133-62	PC Board, 10 pin	81312	KZ 10S
A3J6	133-63	PC Board, 22 pin	81312	KZ 22S
		TRANSISTORS		
A3Q1	81-112	40251	07029	40251
		RESISTORS		
A3R1	44-.27Ω	Fixed, WW, .27Ω, 1/2w, 5% (S/N 267 & above)	75042	BWH-.27Ω
	44-.39Ω	Fixed, WW, .39Ω, 1/2w, 5% (S/N 266 & below)	75042	BWH-.39Ω
A3R2	71-22	Variable, 100K, 2 w	44655	CLU 1041

A4 HEATER REGULATOR PC BOARD 951006

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION	TRUE MFR. FSC NO.	TRUE MFR. PART NO.
		CAPACITORS		
A4C1*		Not used (S/N 32 & above)		
	12-3	Factory select, Nominal value .01 µf, 100 v (S/N 191 & below)	71590	DD-1032
A4C2	13-40	Fixed, elect., 100 µf, 10 v	56289	TE 1119.3
		DIODES		
A4CR1		Not used		
A4CR2	81-43	1N5235B/1/4M6.8Z5	04713	1N5235B
A4CR3	81-41	1N459	07263	1N459
A4CR4	81-123	1N749, 4.3 v	04713	1N749
		INDICATORS		
A4L1	92-7	RF, 10 µhy (S/N 235 & below only)	71895	1025-44
		TRANSISTORS		
A4Q1	81-114	2N3638A	07263	2N3638A
A4Q2	81-115	2N3565	07263	2N3565
A4Q3	81-140	2N5087	04713	2N5087
A4Q4	81-72	2N699	96214	2N699
A4Q5	(81-115)	Same as A4Q2	(07263)	(2N3565)
A4Q6 and A4Q7	81-116	2N3646	07263	2N3646
A4Q8	(81-115)	Same as A4Q2	(07263)	(2N3565)
A4Q9	(81-114)	Same as A4Q1	(07263)	(2N3638A)
		RESISTORS		
A4R1	51-3.3K	Fixed, carb. film, 3.3K, 1/2 w, 5%	73445	E-009-AB/B-3.3K
A4R2	51-560 Ω	Fixed, carb. film, 560 Ω, 1/2 w, 5%	73445	E-009-AB/B-560 Ω
A4R3	51-390 Ω	Fixed, carb. film, 390 Ω, 1/2 w, 5%	73445	E-009-AB/B-390 Ω
A4R4	51-4.7K	Fixed, carb. film, 4.7K, 1/2 w, 5%	73445	E-009-AB/B-4.7K
A4R5	51-820 Ω	Fixed, carb. film, 820 Ω, 1/2 w, 5%	73445	E-009-AB/B-820 Ω
A4R6	51-680 Ω	Fixed, carb. film, 680 Ω, 1/2 w, 5%	73445	E-009-AB/B-680 Ω
A4R7		Not used		
A4R8	51-1.2K	Fixed, carb. film, 1.2K, 1/2 w, 5%	73445	E-009-AB/B-1.2K
A4R9	51-120 Ω	Fixed, carb. film, 120 Ω, 1/2 w, 5%	73445	E-009-AB/B-120 Ω
A4R10	51-100 Ω	Fixed, carb. film, 100 Ω, 1/2 w, 5%	73445	E-009-AB/B-100 Ω
A4R11	51-1.5K	Fixed, carb. film, 1.5K, 1/2 w, 5%	73445	E-009-AB/B-1.5K
A4R12	51-8.2K	Fixed, carb. film, 8.2K, 1/2 w, 5%	73445	E-009-AB/B-8.2K
A4R13	71-106	Variable, comp., 5K, 1/8 w, 30%	71450	XHT-201-5K
A4R14	51-5.6K	Fixed, carb. film, 5.6K, 1/2 w, 5%	73445	E-009-AB/B-5.6K
A4R15	51-470 Ω	Fixed, carb. film, 470 Ω, 1/2 w, 5%	73445	E-009-AB/B-470 Ω
A4R16	(51-100Ω)	Same as A4R10	(73445)	(E-009-AB/B-100Ω)
A4R17*	51-27K	Fixed, carb. comp., 27K, 1/2 w, 5%	73445	E-009-AB/B-27K
A4R18*	51-220 Ω	Fixed, carb. comp., 220 Ω, 1/2w, 5%	73445	E-009-AB/B-270 Ω
A4R19	41-10Ω	Fixed, comp., 10Ω, 1/2w, 10% (S/N 236 & above) Not used (S/N 235 & below)	00121	EB 1001

*Factory Selected - Nominal Values given.

A5 LOW VOLTAGE RECTIFIER ASSY. 951015

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION	TRUE MFR. FSC NO.	TRUE MFR. PART NO.
		DIODES		
A5CR1 thru A5CR16	81-20	1N4385/DI-46	76433	1N4385

Model 5010 A6 HIGH VOLTAGE BIAS PC BOARD 951009

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION	TRUE MFR. FSC NO.	TRUE MFR. PART NO.
		DIODES		
A6CR1	81-184	Zener, 1N4762	04713	1N4762
		RESISTORS		
A6R1	52-340K	Fixed, met. film, 340K, 1 w, 1%	19701	MFS-1-T2-340K
A6R2 thru A6R4	52-250K	Fixed, met. film, 250K, 1 w, 1%	19701	MFS-1-T2-250K
A6R5 thru A6R7		Not used		
A6R8 thru A6R11	43-270K	Fixed, comp., 270K, 2 w, 10%	01121	HB 2741
A6R12 thru A6R16		Not used		
A6R17	41-10 Ω	Fixed, comp., 10 Ω, 1/2 w, 10%	01121	EB 1001

Model 5020 A6 HIGH VOLTAGE BIAS PC BOARD 951011

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION	TRUE MFR. FSC NO.	TRUE MFR. PART NO.
		DIODES		
A6CR1	81-141	Zener, 1N4764A	04713	1N4764A
		RESISTORS		
A6R1 thru A6R3	52-383K	Fixed, met. film, 383K, 1 w, 1%	19701	MFS-1-T2-383K
A6R4	52-392K	Fixed, met. film, 392K, 1 w, 1%	19701	MFS-1-T2-392K
A6R5 thru A6R7		Not used		
A6R8 thru A6R11	43-270K	Fixed, comp., 270K, 2 w, 10%	01121	HB 2741
A6R12 thru A6R16		Not used		
A6R17	51-6.8K	Fixed, carb. film, 6.8K, 1/2 w, 5%	73445	E-009-AB/B-6.8K

Model 5030 A6 HIGH VOLTAGE BIAS PC BOARD 951012

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION	TRUE MFR. FSC NO.	TRUE MFR. PART NO.
		DIODES		
A6CR1	81-141	Zener, 1N4764A	04713	1N4764A
		RESISTORS		
A6R1 thru A6R6	52-374K	Fixed, met. film, 374K, 1 w, 1%	19701	MFS-1-T2-374K
A6R7		Not used		
A6R8 thru A6R11	43-270K	Fixed, comp., 270K, 2 w, 10%	01121	HB 2741
A6R12 and A6R13	43-330K	Fixed, comp., 330K, 2 w, 10%	01121	HB 3341
A6R14 thru A6R16		Not used		
A6R17	51-6.8K	Fixed, carb. film, 6.8K, 1/2 w, 5%	73445	E-009-AB/B-6.8K

Model 5040 A6 HIGH VOLTAGE BIAS PC BOARD 951013

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION	TRUE MFR. FSC NO.	TRUE MFR. PART NO.
		DIODES		
A6CR1	81-141	Zener, 1N4764A	04713	1N4764A
		RESISTORS		
A6R1 thru A6R6	52-383K	Fixed, met. film, 383K, 1 w, 1%	19701	MFS-1-T2-383K
A6R7	52-393K	Fixed, met. film, 392K, 1 w, 1%	19701	MFS-1-T2-392K
A6R8 thru A6R11	43-270K	Fixed, comp., 270K, 2 w, 10%	01121	HB 2741
A6R12 thru A6R14	43-330K	Fixed, comp., 330K, 2 w, 10%	01121	HB 3341
A6R15 and A6R16		Not used		
A6R17	51-6.8K	Fixed, carb. film, 6.8K, 1/2 w, 5%	73445	E-009-AB/B-6.8K

FEDERAL SUPPLY CODE FOR TRUE MANUFACTURERS

FMC NO.	FULL NAME AND ADDRESS OF VENDOR
00656	Aerovox Corporation, 740 Belleville Ave., New Bedford, Mass.
00686	Film Capacitors, Inc., 100 East 8th Street, Passaic, N. J.
00816	Hughes Aircraft Co., Vacuum Div., 500 Superior Avenue, Newport Beach, Calif.
00853	Sangamo Electric Co., P. O. Box 128, Pickens, S. C.
00866	Goe Engineering Co., 219-21 S. Mednik Ave., Los Angeles, Calif.
00929	Microlab/FXR, 10 Microlab Rd., Livingston, N. J.
01121	Allen Bradley Co., 136 W. Greenfield Ave., Milwaukee, Wisc.
01281	Pacific Semiconductor Co., 10451 W. Jefferson Blvd., Culver City, Calif.
01456	Microwave Development Laboratories, 87 Crescent Road, Needham Heights, Mass.
01963	Cherry Electrical Products Corp., Box 439, Highland Park, Ill.
02111	Spectrol Electric Corporation, 17070 E. Gale Ave., City of Industry, Calif. 91745
02114	Ferroxcube Corporation of America, Mt. Marian Rd., Sougerties, N. Y. 12477
02116	Wheelock Signals Inc., 273 Branchport Ave., Long Branch, N. J. 07440
02735	Radio Corp. Solid State & Tube Div., Route 202, Somerville, N. J.
03508	G. E. Semiconductors, Electronics Park, Syracuse, N. Y. 13201
03565	Dayton Electronic Products Co., 117 E. Helena St. Dayton, Ohio
03782	Singer Co., Alfred Operation, 3176 Porter Drive, Palo Alto, Calif. 94304
04009	Arrow-Hart, & Hegeman Elec. Co., 113 Hawthorne St., Hartford, Conn.
04713	Motorola Semiconductor Products, Inc., P. O. Box 955, Phoenix, Arizona
04773	Automatic Electric Co., Wolf Rd., Northlake, Ill. 60164
05063	Avnet Electronic Supply Co., Westbury, New York 11590
05783	Stewart Engineering Co., 467 Bean Creek Rd., Santa Cruz, Calif.
05820	Wakefield Engineering Inc., 139-T Foundry St., Wakefield, Mass.
06049	Topaz, 3802 Houston, San Diego, Calif. 92110
06509	Gulton Ind., Inc., Instr. Prod. Div. West, 13030 Cerise Ave., Hawthorne, Calif. 90250
06555	Beede Electrical Instrument Co., Inc., Penacook, N. H.
06980	Varian, 611 Hansen Way, Palo Alto, Calif. (BWO)
07137	Transistor Electronics Corp., Box 6191, Minneapolis, Minn.
07263	Fairchild Semiconductor, 545 Whisman Rd., Box 880, Mountain View, Calif.
08806	General Electric Corp., Min. Lamp Dept., Nela Park, Cleveland, Ohio
09022	Comell-Dubilier, 50 Paris St., Newark, N. J. (Mica Caps)
09023	Comell-Dubilier, 50 Paris St., Newark, N. J. (Electrolytic Caps)
09297	CP Electronics, Inc., Columbus, Ind.
11312	Microwave Electronics Div. of Teledyne, 3165 Porter Drive, Palo Alto, Calif.
11870	Melabs, Inc., 3300 Hillview, Palo Alto, Calif. 94304
12060	Diodes, Inc., 9261 Independence Ave., Chatsworth, Calif.
12122	Astrodyne, Inc., 2nd Ave., NW. Ind. Park, Burlington, Mass. 01803
12360	Albany Products, 351 Connecticut Ave., South Norwalk, Conn.
12598	RLC Electronics, Inc., 25 Martin Pl., Port Chester, N. Y. 10573
12697	Clarostat Mfg. Co., Washington St., Dover, N. H.
13175	Electro-Mechanical Corp., 701 S. Elmer Ave., Sayre, Pa. 18840
13664	Workman Elec. Prod. Inc., Packing House Rd., Sarasota, Fla. 33578
13862	Alasco Rubber & Plastic Corp., 839 Malcom Rd., Burlingame, Calif.
14026	Spatron, Inc., 715 S. Raymond Ave., Alhambra, Calif. 91803
14433	International Telephone & Telegraph, 3301 Electronic Way, W. Palm Beach, Florida
14482	Watkins-Johnson Co., 3333 Hillview, Palo Alto, Calif.
14551	Wesco Electronics, Los Angeles, Calif.
15582	Bay City Screw & Bolt Co., 601 Industrial Way, San Carlos, Calif.
15818	Amelco, 1300 Terra Bella, Mt. View, Calif. 94042
16299	Corning Glass Works, Electronic Products Div., 3906 Electronics Dr., Raleigh, N. C.
16741	Triad Dist. Div. (Litton Ind.) 305 N. Briant St., Huntington, Ind.
17474	Tranex, Inc., 1599 Stierlin Rd., Mountain View, Calif.
17545	Atlantic Semiconductors, Inc., 905 Mattison Ave., Asburg Park, N. J. 07712
17920	Warnecke Electron Tubes, 175 W. Oakton St., Des Plaines, Ill.
18489	Reliable Capacitors Co., 14716 Arminta St., Van Nuys, Calif.
18741	High Vacuum Electronics, Inc., 538 Mission St., South Pasadena, Calif. 91030
18915	Birtcher Corp., The Industrial Div., 745 S. Monterey Pass Rd.,Monterey Park, Calif.
19701	Electra Mfg. Co., 800 North 21st., Independence, Kansas
20286	Daytron, Inc., 1269 Terra Bella, Mountain View, Calif.
20649	Universal Metal Products, 5924 N. Western Ave., Chicago 45, Ill.
21030	Beckman Instrument Inc., Helipot Div., 2500 Harbor Blvd., Fullerton, Calif.
21743	Canseat Corp., 4164 Greenbush Ave., Sherman Oaks, Calif.
22229	Union Carbide, Kemet Elect. Div., Mountain View, Calif.
23095	Aztec Electronics, Inc., 163 Liberty Ave., Anaheim, Calif.
23585	Hunter Associates Laboratory, Inc., 9529 Lee Highway, Fairfax, Va. 22030
23880	Stanford Applied Engineering, 340 Martin Ave., Santa Clara, Calif. 95050
24220	Gowanda, 179 Broadway Rd., Gowanda, N. Y.
24796	Parelco, Inc., 26181 Avenida Aeropuorto, San Joan Capistrano, Calif. 92675
24931	Spec. Connector Co., 3560 Madison Ave., Indianapolis, Ind., 46227
26769	National Capacitors, Inc., (NCI), 5900 Voss Rd., W. Palm Beach, Fla 33407
27014	National Semi-Conductor Corp., 2950 San Ysidro Way, Santa Clara, Calif.
28480	Hewlett-Packard, Paeco Div., 3215 Porter Drive, Palo Alto, Calif. 94304
29083	Monsanto Co., Inc., 2710 Lafayette, Santa Clara, Calif. 95050
31870	Viking Electronics, Inc., 721 St. Croix, Hudson, Wisconsin 54016
31918	International Electronics Exchange, 6529 Cambridge St., Minneapolis, Minn. 55426
32293	Intersil, Inc., 10900 N. Tantau Ave., Cupertino, Calif. 95014
33173	General Electric Corporation, Tube Dept., 316 E. Ninth St., Owensboro, Ky.
35434	Lectrohm, Inc., 5560 Northwest Hwy., Chicago, Ill.
37942	Mallory Capacitor Co., Div. P. R. Mallory & Co., Inc. 3029 E. Washington St. Indianapolis, Ind.
42190	The Muter Co.,1255 S. Michigan Ave., Chicago 5, Ill.
42498	National Radio Co., 111 Washington St., Melrose, Mass., 02176
43543	Nytronics, Inc., Transformer Co. Div., 3rd Avenue, Alpha, N. J. 08866
44655	Ohmite Mfg. Co., 3635 W. Howard St., Skokie, Ill.
46384	Penn Engineering, West State St., Doylestown, Penn.
56289	Sprague Electric Co., 91 Marshall St., N. Adams, Mass.
59730	Tyrap, C/O Thomas & Betts Co., 645 Phelps St., San Francisco, Calif.
70309	Allied Control Co., 2 East End Ave., New York, N. Y.
70318	Allmetal Screw Products Co., Inc., 821 Stewart Ave., Garden City, N. Y.
70563	Amperite Co., Inc., 600 Palisade Ave., New Jersey
70903	Belden Mfg. Co., Box 5070-A, Chicago, Ill. 60644
71436	Chicago Condenser Corporation, 3253 Armitage Ave., Chicago, Ill. 60647
71450	CTS Corp., 1172 W. Beardsley, Elkhart, Ind.
71590	Centralab, Electronics Div., Globe Union, 934 Keefe Ave., Milwaukee, Wisc.
71707	Cato Coil Co., Inc., Box B, Edgewood Station, Providence, R. I.
71785	Cinch Mfg. Co., 1026 S. Homan Ave., Chicago 24, Ill.
71895	Delavan Mfg. Co., Electro-Sonics Div., West Des Moines, Iowa
72012	M. Ducommun Mfg. Co., 580 Fifth Ave., New York, N. Y. 90036
72136	Electro Motive Mfg. Co., Inc., S. Park & John Streets, Willimantic, Conn. 06226
72765	Drake Mfg. Co., 4626 N. Olcott Ave., Harwood Heights, N. Y. 60656
72982	Erie Technological Products, Inc., 644 W. 12th St., Erie, Penn.
72983	Stancor Electronics (Essex Wire Corp.) 3501 W. Addison St., Chicago, Ill.
73293	Hughes Aircraft Co., Elec. Comp. Div., 500 Superior Ave., Newport Beach, Calif.
73445	Amperex Electronic Corporation, Box 418. 230 Duffy Ave., Hicksville, N. Y.
73559	Carling Electric Inc., 505 New Park Ave., West Hartford, Conn. 06110
73899	JFD Elect. Co., Comp. Div., 15th Ave. at 62nd St., Brooklyn, N. Y.
74542	Hoyt Electrical Inst. Works, Inc., 42 Carleston St., Cambridge, Mass.
74868	Amphenol Corp., Connector Div., 1830 S. 54th Ave., Chicago, Ill.
74970	The E. F. Johnson Co., 1923 10th Ave., S.W. Waseca, Minn.
75376	Kurz Kasch, 1417 S. Broadway, Dayton, Ohio
75382	Kulka Electric Corp., 520 S. Fulton Ave., Mt. Vernon, N. Y.
75042	IRC, Inc., 401 N. Broad St., Philadelphia, Penn.
75497	Lamson & Sessions, 5002 Tiedeman Rd., Cleveland, Ohio
75915	Littlefuse, Inc., 800 E. Northwest Hwy., Des Plaines, Ill.
76433	General Instrument Corp., 65 Gouverneur, Newark, N. J.
76487	James Millen Mfg. Co., Inc., 150 Exchange St., Malden, Mass. 02148
76854	Oak Mfg. Co., S. Main Street, Crystal Lake, Ill. 60014
77342	Potter & Broomfield, Div. of American Machine & Foundry Co., 1200 E. Broadway, Princeton, Indiana
77557	Reliable Spring & Wire Forms Co., 3167 Fulton Rd., Cleveland, Ohio
78553	Tinnerman Co., Dept. 16-T, P. O. Box 6688, Cleveland, Ohio
78947	Ucinite Corporation, 459 Watertown St., Newtonville, Mass. 02160
79493	J. W. Miller Co., 5915 S. Main St., Los Angeles, Calif. 90003
80294	Bourns, Inc., 1200 Columbia Ave., Riverside, Calif. 92507
81073	Grayhill, Inc., 569 Hillgrove Ave., La Grange, Ill.
81312	Winchester Electronics, Inc., Div. Litton Industries, 19 Willard Rd., Norwalk, Conn.
82219	Sylvania Electric Prod., Revg. Tube Div., Emporium, Pa.
82389	Switchcraft, Inc. 5555 N. Elston Ave., Chicago 30, Ill.
83186	Victory Engineering, 128 Springfield Ave., Springfield, N. J.
83701	Electronic Devices Inc., 21 Grey Oaks Ave., Yonkers, N. Y.
84411	TRW Capacitor Div., 112 West First Street, Ogallala, Nebraska
86684	Radio Corp. of America, Electronic Components & Devices, 415 S. 5th St., Harrison, N. J.
88245	USECO, Div. of Litton Industries, 13536 Saticoy St., Van Nuys, Calif.
89110	AMP, Inc., 155 Park St., Elizabethtown, Penn.
89536	John Fluke Mfg. Co., Inc., P. O. Box 7428, Seattle, Wash.
91278	Stoesser Tool & Die, 3366 Fayette Dr., Mountain View, Calif.
91418	Radio Materials Co., 4242 W. Bryn Mawr Ave., Chicago 46, Ill.
91637	Dale Electronics, Inc., (Subs. Lionel Corp.) Box 609, 1342 28th Street, Columbus, Nebr.
91737	Gremar Mfg. Co., Wakefield, Mass.
91755	Harrison & Bonini, 1122 Harrison St., San Francisco, Calif.
91827	K & F Tool Die & Mfg., Inc., 1203 Dell Ave., Campbell, Calif.
92219	Waldom Electronics, Inc., 4625 W. 53rd St., Chicago, see 60632.
93332	Sylvania Electric Products, Inc., Semiconductor Div., 100 Sylvan Rd., Woburn, Mass.
93389	Proto Stamping, Washington & Santa Fe, Los Angeles 54, Calif.
94144	Raytheon, 465 Centre St., Quincy, Mass. 02164
94375	Automatic Metal Products Corp., 323 Berry St., Brooklyn 11, N. Y.
94696	Magnecraft Electric Co., 5579 N. Lynch Rd., Chicago, Ill. 60630
95263	Leecraft Mfg. Co., Inc., 21-16 44th Rd., Long Island City, N. Y. 11101
95348	Gordos Corp., 250 Glenwood Ave., Bloomfield, N. J. 07003
95354	Methode Electronics, Inc., 7447 W. Wilson Ave., Chicago, Ill.
95712	Bendix Corp., Microwave Devices Div., (Dage), Franklin, Ind.
95987	Weckesser Co. Inc., 4444 W. Irving Park, Chicago, Ill.
96214	Texas Instruments, Inc., Semiconductor-Components Div., Box 5012, Dallas, Texas
96791	Bunker-Ramo Corp., Amphenol Industrial Div., Jonesville, Wisc.
97464	Industrial Retaining Ring Co., 57 Cordier St., Irvington, N. J.
98003	Neilson Hardware Corp., 770 Weathersfield Ave., Hartford, Conn.
99120	Plastic Capacitors, Inc., 2620 N. Clybourn Ave., Chicago, Ill.
99313	Varian, 611 Hansen Way, Palo Alto, Calif. (BWO) 94304
99779	Barnes Dev. Co., 213 W. Baltimore Pike, Lansdowne, Pa. 19050
99942	Hoffman Electronics Corp., Semiconductor Div., Box 471, El Monte, Calif.

SECTION 7

SCHEMATIC DIAGRAMS

Schematics are included in the following order:

Model 5000 Main Chassis	D900842
A1 Low Voltage Regulator PC Board 951005	C900912
A2 High Voltage Regulator PC Board 951014	C900913
A4 Heater Regulator PC Board 951006	C900911
A6 High Voltage Bias PC Board **	B900914 †

** Refer to List of Assemblies (Section 6) for correct Alfred Part No.
† Printed on apron of D900842

Tube Warranty and Replacement Procedures

Singer Instrumentation, Palo Alto Operation

TUBE REPLACEMENT

All TWT and BWO tubes furnished in Singer/Alfred instruments are available from Singer Instrumentation, Palo Alto Operation for either warranty or out-of-warranty replacements. Current prices are given on the Replacement Tube Price List.

TUBE WARRANTY

The following warranties are applicable to tubes used in catalog instruments only. For the warranty applicable to tubes used or for use in special or modified instruments, please check with the factory. All tube warranties are from date of shipment by Singer Instrumentation, Palo Alto Operation.

WARRANTY

Tubes are warranted unconditionally against defects in workmanship, materials, and construction within the period shown in Column A and the number of heater hours shown in Column B. To supplement the unconditional warranty, the tubes are warranted on a pro-rata basis for the rated number of heater hours shown in Column C or for one year, both computed from the date of original shipment by Singer Instrumentation, Palo Alto Operation, whichever expires first. The pro-rated adjustment will be based on the current list price of the tube and the unused percentage of heater hours (Column C) or one-year time period, whichever results in lesser credit.

Warranty Condition *	Applicable Tube Group or Tube Part No. Series	A Mo.	B Hours	C Hours
WC2	112-001 and 112-003	2	100	1000
WC4	112-040 and 112-047	12	2000	--
WC5	1 watt output except WC6 tubes	12	1500	--
WC6	112-046	12	1000	--
WC8	112-042, 112-043, 112-044 and 112-045	12	--	--
WC10	Warranted unconditionally for one (1) year.			

*WC# denotes the corresponding warranty period(s) shown in the right-hand column(s) and is used for cross-reference to this warranty statement from other documents.

WC10 WARRANTY

Tubes are warranted unconditionally against defects in workmanship, materials, and construction within the period shown above, without regard to the number of heater hours used. A tube supplied to replace a defective in-warranty tube is covered by warranty only for the remainder of the original tube warranty period.

WARRANTY CONDITIONS APPLY ONLY TO TUBES LISTED ABOVE WHICH ARE USED IN CATALOG INSTRUMENTS.

This warranty applies only to tubes sold after May 15, 1972.

TUBE SERVICE REPORT

TO OBTAIN WARRANTY CREDIT THE TUBE SERVICE REPORT MUST BE COMPLETED AND RETURNED WITH THE TUBE.

RETURN PROCEDURE

In case a tube or instrument fails, please contact the factory or your local sales representative for advice or authorization to return either the tube or the instrument to the factory. NO TUBE OR INSTRUMENT WILL BE ACCEPTED FOR REPAIR OR CREDIT ADJUSTMENT WITHOUT WRITTEN AUTHORIZATION AND ACCOMPANYING SERVICE REPORT.

When the authorization is received, pack the tube in a rigid container (use original carton if available) at least 4" larger than the tube in each dimension. Wrap the tube with 1/4" of soft padding material and heavy kraft paper before placing in container. Pack at least 2" of resilient dunnage such as rubberized hair, foam, or similar shock absorbing material completely around the tube. Mark the container "FRAGILE" and ship PREPAID via air freight, air express or rail express. Do not ship via parcel post or air parcel post since experience has shown that fragile items are more apt to be damaged when shipped via these methods.

Use similar wrapping, packing and shipping provisions for an instrument. At least 6" of rubberized hair (or equivalent shock absorbing material) is required for an instrument.

IN-WARRANTY FAILURE–BWO AND VTM TUBES

BWO and VTM tubes which fail in warranty will be replaced with a new tube. In case a tube fails, please issue a purchase order for a new tube at the tube list price and return the defective tube. Warranty credit will be issued and deducted from the price, subject to tube manufacturer's verification that failure was caused by tube malfunction. To qualify for maximum credit, it is essential that the defective tube be properly packed and returned within 30 days after failure.

REPAIRABLE OR IN-WARRANTY FAILURE–TW TUBES

If the returned tube is found to be repairable, the user will be asked to issue a purchase order for repair charges determined by the original tube manufacturer. In general, the repair will be at no cost if the tube is in warranty and there is no evidence of misuse or abnormal conditions of operation.

WARRANTY CREDIT

Any applicable credit allowed under the terms of this warranty applies only toward the purchase of a replacement tube from Singer Instrumentation, Palo Alto Operation. Cash settlements will not be made. In terms of this warranty, a replacement tube must be the same type as that on which credit is allowed. Credit for one tube only may be applied toward the purchase of a single replacement tube. Warranty credit remains in effect for a maximum of six (6) months from date of notification. All credit will be based on the purchase price of the tube which prevails at the time the order for a replacement tube is received in our plant.

BWO RF CABLES

RF OUTPUT CABLE MUST ACCOMPANY BWO TUBES returned for warranty credit, repair or replacement. If rf output cable is NOT returned, the cable price is added to the normal BWO repair or replacement charge. For prices see Replacement Tube Price List.

SPECIAL CONDITIONS

If a returned tube or instrument proves not to be defective after test and evaluation, the tube or instrument will be returned at the customer's expense.

The final determination as to whether the tube failed in normal operation thereby bringing it under the applicable warranty or whether the tube was misused thereby excluding it from application of the warranty provisions, lies solely with the tube manufacturer.

Data, warranty credit, and prices subject to change without notice.

SINGER
INSTRUMENTATION

May 15, 1972

Service Report

Instrument Model _____ Serial No. _____ Date Received _____

TW/BWO Tube Type _____ Serial No. _____ Date Received _____

Date First Tested _____ Date Placed in Service _____ Date of Failure _____

Total Number of Hours of TWT/BWO Heater Operation _____

_____

1. Was operation normal just prior to failure? Yes _____ No _____

2. If not, what was done to adjust it? _____

_____

3. Has proper cooling been maintained during tube operation? _____

_____

4. Did helix overcurrent tripout occur? _____

5. Was environment normal? (specify) _____

_____

6. Symptoms (describe failure) _____

_____

_____

7. Operating conditions at time of failure (indicate any unusual conditions) _____

_____

_____

8. Name of person to contact regarding evaluation of failure _____

Telephone No. _____ Signature _____

Title _____

Date _____

SINGER
INSTRUMENTATION

The Singer Company, Palo Alto Operation, 3176 Porter Drive, Palo Alto, California 94304
Telephone: (415) 493-3231 TWX: 910-373-1765

SHIPMENT DAMAGE CLAIM

The instrument should be tested as soon as it is received. If it fails to operate properly or is damaged in any way, a claim must be filed with the carrier. Have carrier agent inspect damage to instrument and packing crate and forward us a copy of his written report. You will then be advised of replacement or repair arrangements and disposition of the equipment. Please include model number, type number and serial number when referring to this instrument for any reason.

REPACKING FOR SHIPMENT

The instrument should be packed in the original carton. If unusable or not available, use a wooden box with approximately three inches of excelsior or other shock-absorbing material surrounding the instrument. If desired, packing services of a local transfer and storage company may be employed.

SINGER
INSTRUMENTATION

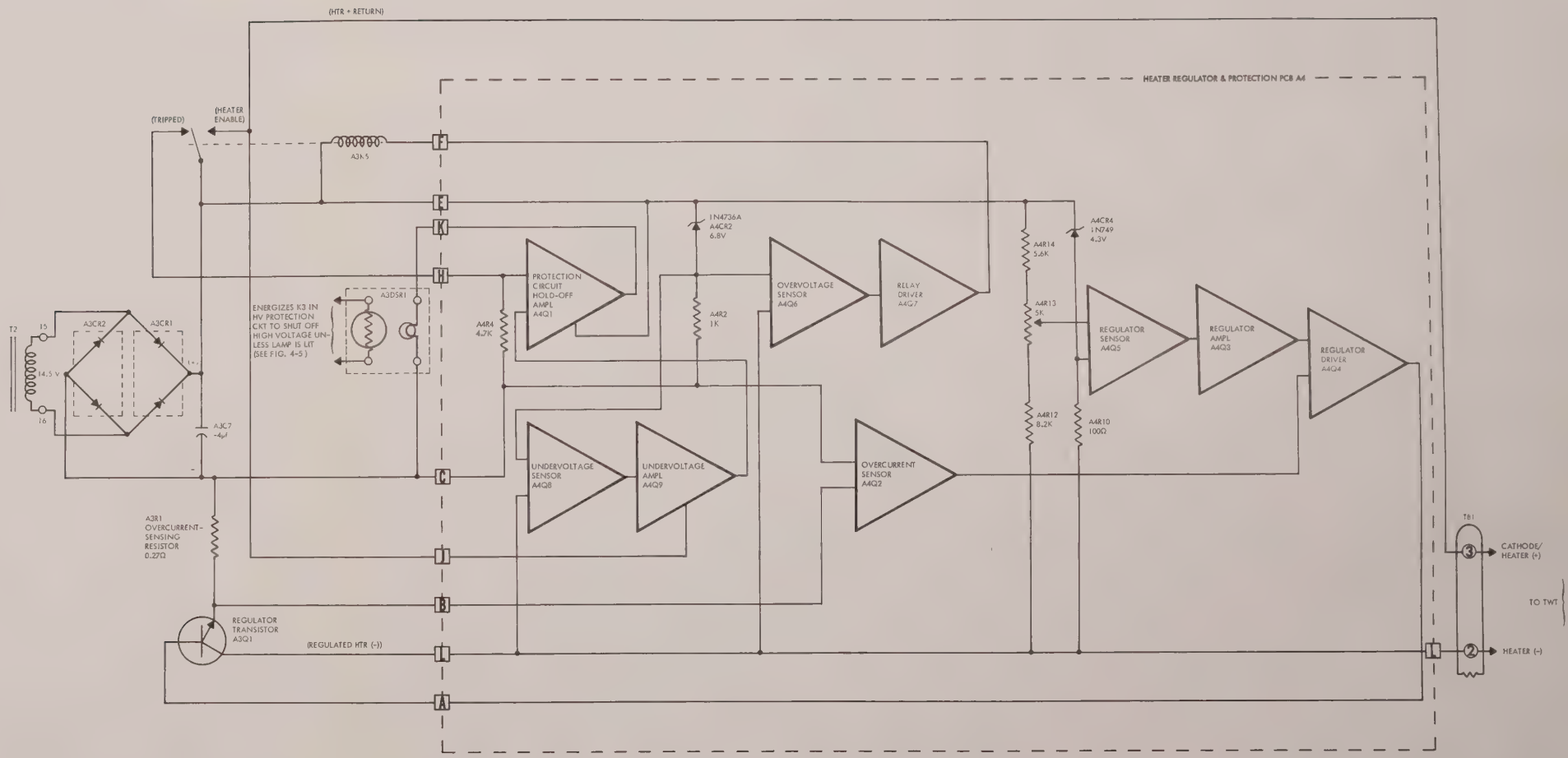
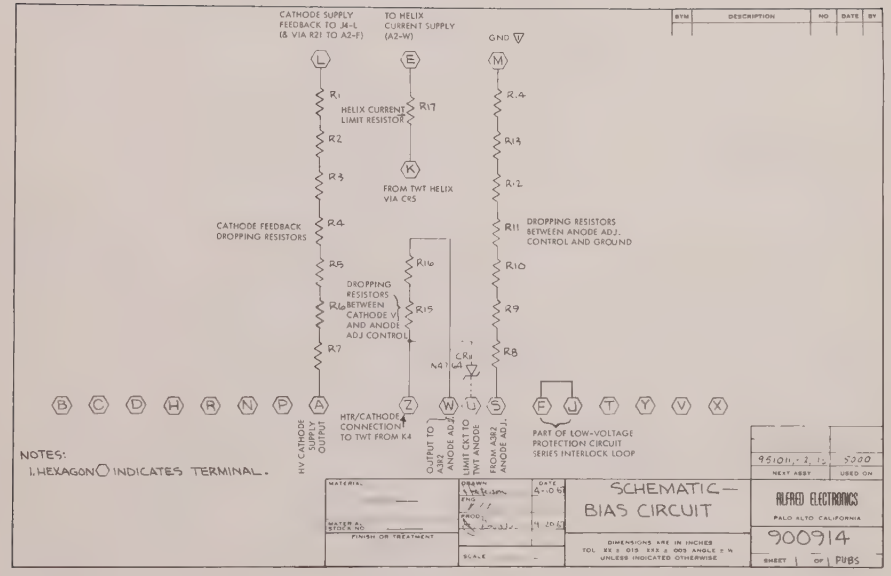
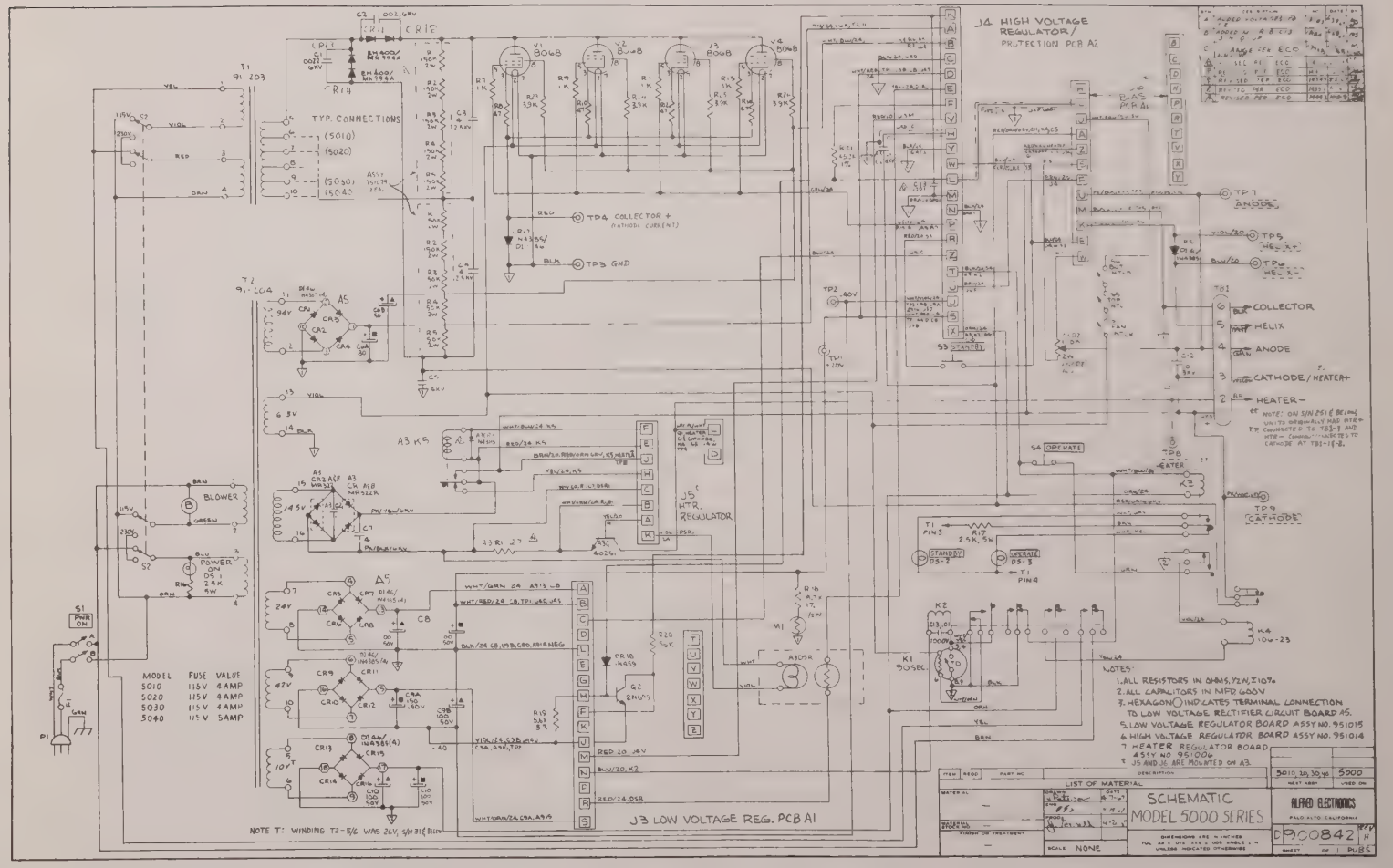


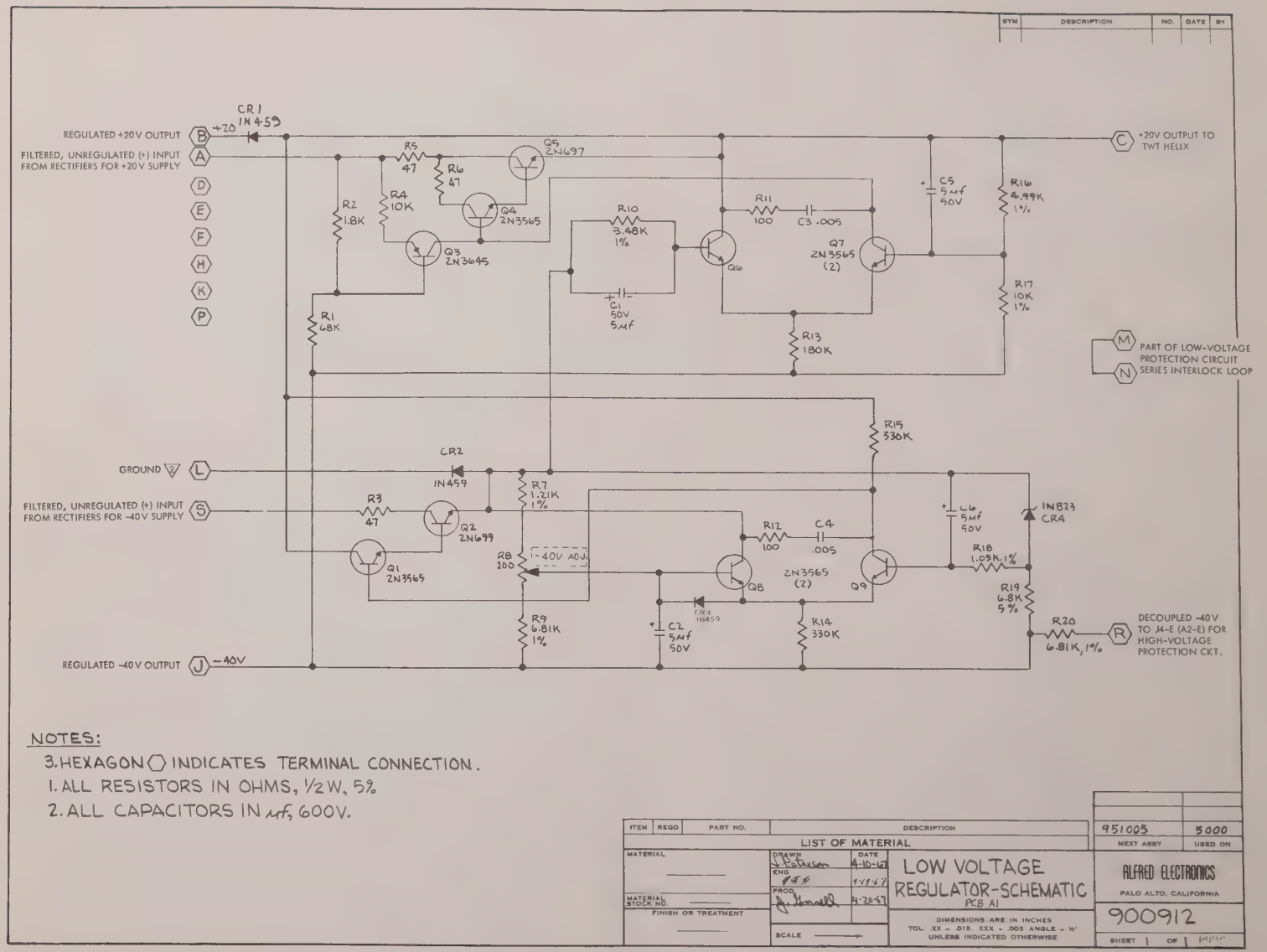
FIGURE 4-3. BLOCK DIAGRAM OF HEATER REGULATOR AND PROTECTION CIRCUITS

Table 4-2. Summary of Protection Relay Operation and Function.

RELAY	ENERGIZED BY	DE-ENERGIZED BY	FUNCTION
K1	Pressing the Power ON pushbutton, which provides +6.3 Vac to the K1 coil (K1-1) from T2-13. The other side of the heater coil (K1-6) is grounded through the normally-closed Form D contacts of K2. The contacts of K1 do not operate until 90 seconds after power is applied to its coil.	K1 is de-energized after 90 seconds by operation of K2 form D contacts, immediately after K2 is energized by the closing of the K1 contacts after the 90 second delay interval.	K1 provides the 90 second delay after power turn-on which allows stabilization of all regulation circuits controlling power to the TWT before high voltage is applied to the tube. After the 90 second delay, K1 operates and its contacts 8-3 energize protection relay K2. K1 is de-energized by the operation of the K2 form D contacts which open-circuit the K1 drive coil.
K2	K2 is energized by K1 after the 90-second warm-up delay interval, provided all series interlocks of the low-voltage protection circuit loop (PC insertion, top cover, bottom cover, and air flow, Figure 4-4) are satisfied. The K1 contact supplies the ground connection to one side of the K2 coil, and this connection self-latches through the K2 Form D contacts. The 6.3 V ac connection to the other side of the coil (blue wire) is completed from T2-13 through S7, S5, S6, J6-J/F, J4-U/V, and J3-M/N.	K2 is de-energized by power turn-off or by any open-circuit within the series protection interlock circuit which provides +6.3 Vac as listed at left.	Provides turn-on of high voltage power supply circuits to initiate "Standby" mode. Enables subsequent establishment of "Operate" mode. When K2 is energized, its various contacts perform the following functions: The N.C. contacts of the middle Form C set open and remove the ground connection from the wht/blu lead of the K3 coil permitting K3 to be de-energized when the OPERATE button is pressed (but K3 remains energized through its self-latching Form D contacts until that time). The N.O. contacts of its microswitch supply line power to high voltage transformer T1. This energizes the high voltage cathode supply in readiness for the "operate" mode (but these voltages are not applied to the TWT until K4 is energized in the "Operate" mode). The N.O. contacts of the Form C set closest to the relay coil connect the +12 V dc unregulated supply output to the yellow lead of high voltage control relay K4. The Form D contacts (farthest from the relay coil) self-latch the ground connection of the K2 coil so that K2 will remain energized as long as power remains on and the interlocks are unbroken. At the same time, these contacts disconnect the K1-6 time delay relay heater coil from ground so that the coil will cool off and thereby be ready to provide a new 90-second delay in turn-on of high voltage power if power is interrupted for any reason.
K3	K3 is initially energized by pressing the Power ON pushbutton, which provides +12 V to one side of the K3 coil (orange wire) while the other side (white/blue wire) is connected to ground through the N.C. contacts of the middle Form C set on K2. After K2 is energized (to de-energize K3), this same circuit path will re-energize K3 (to de-energize K4 and remove high voltage from the TWT) whenever K2 is de-energized by defeat of any of the series protection circuit interlocks. Additional protection circuits contained in A2 can also re-energize K3 to remove high voltage from the TWT, by grounding A2-T (to complete the ground connection to the white/blue lead of the K3 coil) if helix overcurrent or heater overcurrent or incorrect heater voltage occur. The same protection circuit also is triggered to ground A2-T when the STANDBY button is pressed.	K3 is de-energized by pressing the Operate button which breaks the coil ground connection loop otherwise provided by its self-latching Form D contacts. It is also de-energized by power turn-off. If the A2 protection circuits are tripped, J4-T will be held at ground, and pressing the OPERATE button will not break the ground connection. Also, if relay K2 is not energized, its middle Form C contact set will maintain the ground connection to the K3 coil. In either of these cases, K3 will remain energized to prevent the operation of K4.	K3 controls high voltage control relay K4 (which applies high voltage to the TWT), so that when K3 is energized, K4 is de-energized to remove high voltage from the TWT. When K3 is de-energized, K4 is enabled to operate (if K2 is also energized) to connect high voltage to the TWT. The K3 Form D contacts control the ground connection of one side (violet wire) of the K4 coil, connecting it to ground only when K3 is de-energized. When K3 is energized (either through normal instrument turn-on or by operation of a protection circuit to switch out of the "Operate" mode) its Form D contacts provide a self-latching ground connection to the controlled side of its coil (white/blue wire). Thus, it can only be de-energized by pressing the OPERATE button, which breaks the self-latching loop if there are no protection circuit outages. The K3 Form C contacts control the STANDBY and OPERATE lights. When K3 is energized and power is available from Terminal 4 of high voltage transformer T1 (when K2 is operated after the 90-second turn-on delay interval), the instrument is in "Standby" mode and DS-2 is lit.


CATHODE SUPPLY FEEDBACK TO J4-L (B VIA R21 TO A2-F)
TO HELIX CURRENT SUPPLY (A2-W)
GND
HELIX CURRENT LIMIT RESISTOR
FROM TWT HELIX VIA CR5
CATHODE FEEDBACK DROPPING RESISTORS
DROPPING RESISTORS BETWEEN ANODE ADJ. CONTROL AND GROUND
DROPPING RESISTORS BETWEEN CATHODE V. AND ANODE ADJ. CONTROL
HV CATHODE SUPPLY OUTPUT
HTR/CATHODE CONNECTION TO TWT FROM K4
OUTPUT TO A3R2 ANODE ADJ.
LIMIT CKT TO TWT ANODE
FROM A3R2 ANODE ADJ.
PART OF LOW-VOLTAGE PROTECTION CIRCUIT SERIES INTERLOCK LOOP
NOTES:
1. HEXAGON ⬡ INDICATES TERMINAL.
SCHEMATIC — BIAS CIRCUIT
ALFRED ELECTRONICS
PALO ALTO CALIFORNIA
900914
951011, -2, -3
5020
NEXT ASSY
USED ON
DIMENSIONS ARE IN INCHES
TOL .XX ± .015 .XXX ± .005 ANGLE ± ½
UNLESS INDICATED OTHERWISE
SHEET 1 OF 1 PUBS


J4 HIGH VOLTAGE REGULATOR/ PROTECTION PCB A2
J3 LOW VOLTAGE REG. PCB A1
A5 HTR. REGULATOR
TYP. CONNECTIONS
(5010)
(5020)
(5030) (5040)
TP1 ANODE
TP2 -60V
TP3 GND
TP4 COLLECTOR + (CATHODE CURRENT)
TP5 HELIX +
TP6 HELIX -
TP7 CATHODE/HEATER+
TP8 HEATER -
TP9 CATHODE
COLLECTOR
HELIX
ANODE
CATHODE/HEATER+
HEATER -
BLOWER
POWER ON DS-1 2.5K 9W
STANDBY DS-2
OPERATE DS-3
MODEL FUSE VALUE
5010 115V 4AMP
5020 115V 4AMP
5030 115V 4AMP
5040 115V 5AMP
NOTE T: WINDING T2-5/6 WAS 26V, S/N 318 BELOW
NOTES:
1. ALL RESISTORS IN OHMS, ½W, ±10%
2. ALL CAPACITORS IN MFD 600V
3. HEXAGON ⬡ INDICATES TERMINAL CONNECTION TO LOW VOLTAGE RECTIFIER CIRCUIT BOARD #5.
5. LOW VOLTAGE REGULATOR BOARD ASSY NO. 951015
6. HIGH VOLTAGE REGULATOR BOARD ASSY NO. 951014
7. HEATER REGULATOR BOARD ASSY NO 951006
* J5 AND J6 ARE MOUNTED ON A3.
LIST OF MATERIAL
SCHEMATIC MODEL 5000 SERIES
ALFRED ELECTRONICS
PALO ALTO CALIFORNIA
DP900842
5010, 20, 30, 40
5000
SCALE NONE
DIMENSIONS ARE IN INCHES
TOL .XX ± .015 .XXX ± .005 ANGLE ± ½
UNLESS INDICATED OTHERWISE
SHEET 1 OF 1 PUBS



NOTES:

3. HEXAGON ⬡ INDICATES TERMINAL CONNECTION.
1. ALL RESISTORS IN OHMS, 1/2 W, 5%
2. ALL CAPACITORS IN mf, 600V.

ITEM	REQD	PART NO.	DESCRIPTION
			LIST OF MATERIAL

951005	5000		
NEXT ASSY	USED ON		

MATERIAL
MATERIAL STOCK NO.
FINISH OR TREATMENT

DRAWN — DATE 4-10-67
ENG — DATE 4-11-67
PROD — DATE 4-28-67
SCALE

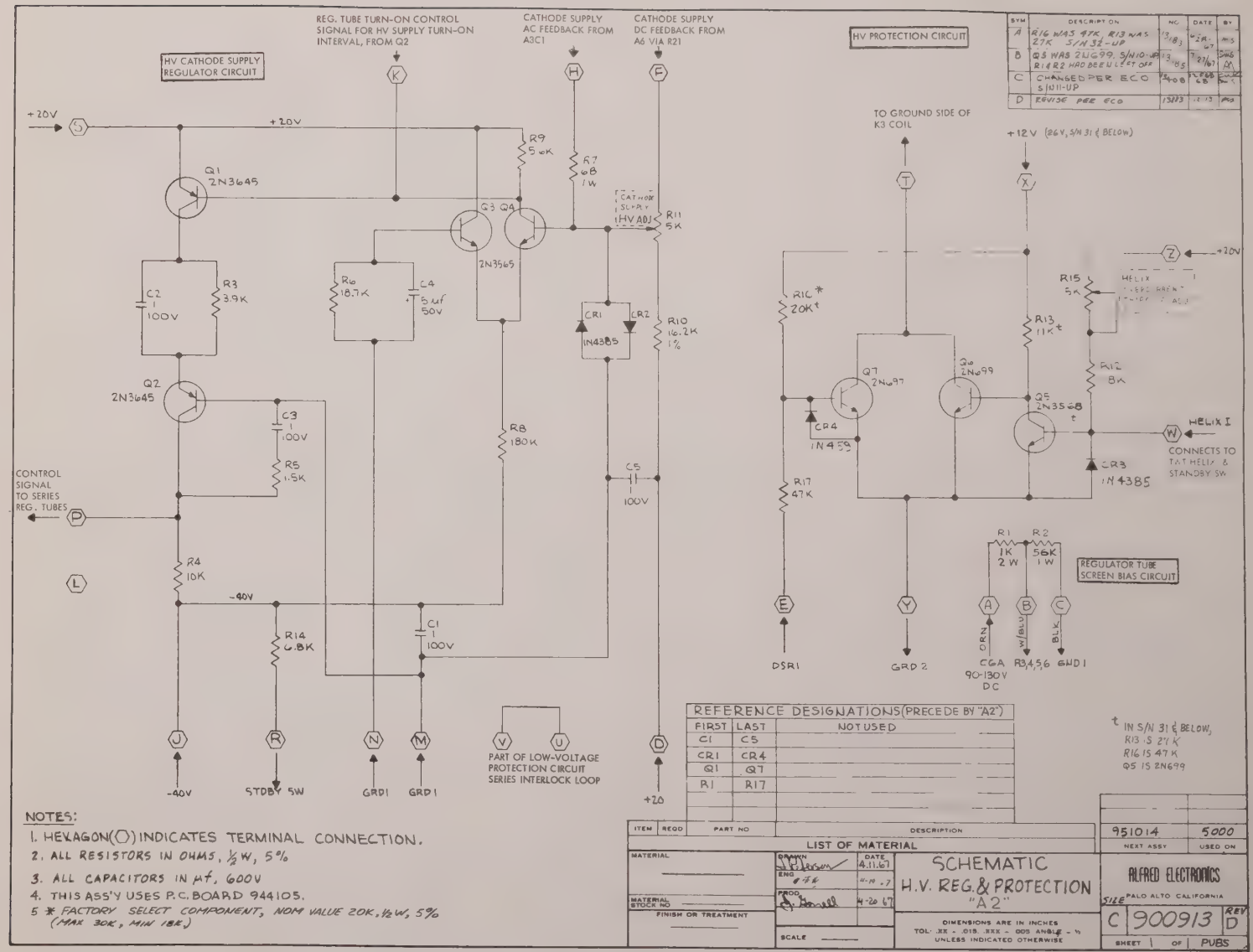
LOW VOLTAGE REGULATOR-SCHEMATIC
PCB A1

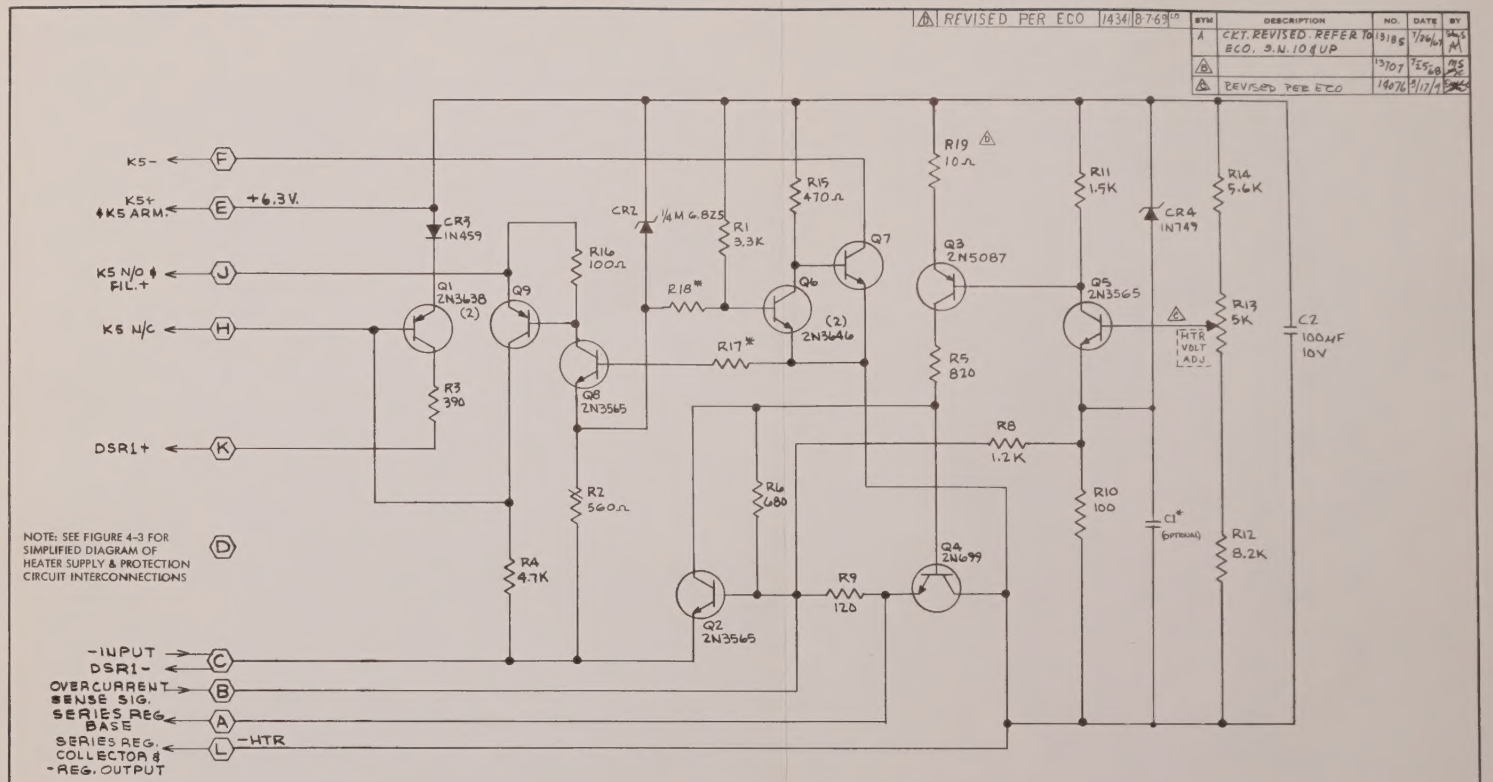
DIMENSIONS ARE IN INCHES
TOL .XX ± .015, .XXX ± .005 ANGLE ± ½°
UNLESS INDICATED OTHERWISE

ALFRED ELECTRONICS
PALO ALTO, CALIFORNIA

900912

SHEET 1 OF 1


HV CATHODE SUPPLY REGULATOR CIRCUIT
REG. TUBE TURN-ON CONTROL SIGNAL FOR HV SUPPLY TURN-ON INTERVAL, FROM Q2
CATHODE SUPPLY AC FEEDBACK FROM A3C1
CATHODE SUPPLY DC FEEDBACK FROM A6 VIA R21
HV PROTECTION CIRCUIT
+20V
Q1 2N3645
R9 5.6K
R7 68 1W
CATHODE SUPPLY HV ADJ
R11 5K
Q3 Q4 2N3565
R3 3.9K
C2 1 100V
R6 18.7K
C4 5 uf 50V
CR1 IN4385
CR2
R10 16.2K 1%
Q2 2N3645
C3 1 100V
R5 1.5K
R8 180K
C5 100V
CONTROL SIGNAL TO SERIES REG. TUBES
R4 10K
-40V
R14 6.8K
C1 1 100V
PART OF LOW-VOLTAGE PROTECTION CIRCUIT SERIES INTERLOCK LOOP
-40V
STDBY SW
GRD1
GRD1
+20
TO GROUND SIDE OF K3 COIL
+12 V (26V, S/N 31 & BELOW)
R16* 20K†
R13 11K†
R15 5K
HELIX
Q7 2N697
Q6 2N699
Q5 2N3568 †
R12 8K
CR4 IN459
CR3 IN4385
HELIX I
CONNECTS TO TAT HELIX & STANDBY SW
R17 47K
R1 1K 2W
R2 56K 1W
REGULATOR TUBE SCREEN BIAS CIRCUIT
DSR1
GRD 2
CGA 90-130V DC
ORN
W/BLU
BLK
R3,4,5,6
GND1
REFERENCE DESIGNATIONS (PRECEDE BY "A2")
FIRST LAST NOT USED
C1 C5
CR1 CR4
Q1 Q7
R1 R17
† IN S/N 31 & BELOW, R13 IS 27K R16 IS 47K Q5 IS 2N699
NOTES:
1. HEXAGON(⬡) INDICATES TERMINAL CONNECTION.
2. ALL RESISTORS IN OHMS, ½W, 5%
3. ALL CAPACITORS IN μf, 600V
4. THIS ASS'Y USES P.C. BOARD 944105.
5 * FACTORY SELECT COMPONENT, NOM VALUE 20K, ½W, 5% (MAX 30K, MIN 18K)
ITEM REQD PART NO DESCRIPTION
LIST OF MATERIAL
MATERIAL
MATERIAL STOCK NO
FINISH OR TREATMENT
DRAWN 4.11.67
ENG
PROD 4-20-67
SCALE
SCHEMATIC H.V. REG. & PROTECTION "A2"
DIMENSIONS ARE IN INCHES TOL .XX ± .015 .XXX ± .005 ANGLE ± ½ UNLESS INDICATED OTHERWISE
951014 5000
NEXT ASSY USED ON
ALFRED ELECTRONICS PALO ALTO CALIFORNIA
SIZE C 900913 REV D
SHEET 1 OF PUBS



SYM	DESCRIPTION	NO.	DATE	BY
A	CKT. REVISED. REFER TO ECO. S.N. 10 & UP	13185	7/26/67	JAS M
B		13707	12/5/68	JAS JE
A	REVISED PER ECO	14076	8/17/9	JAS

NOTES:
1. HEXAGON ⬡ INDICATES TERMINAL CONNECTION. ON ASSY 951006
2. ALL RESISTORS IN OHMS, ½W, 5%.
3. ALL CAPACITORS IN μf, 600V.
4. * FACTORY SELECTED.
5. THIS ASS'Y USES P.C. BOARD 944107.
6. PREFIX REF. DESIGNATORS WITH "A4"

REFERENCE DESIGNATIONS (PRECEDE BY A4)

FIRST	LAST	NOT USED
C1	C2	
CR2	CR4	CR1
Q1	Q9	
R1	R19	R7

ITEM	REQD	PART NO.	DESCRIPTION
			LIST OF MATERIAL

951006	5000
NEXT ASSY	USED ON

MATERIAL
MATERIAL STOCK NO.
FINISH OR TREATMENT

		DATE
DRAWN	L. Patterson	4-7-67
ENG		4-19-67
PROD	A. Arnell	4-20-67
SCALE		

SCHEMATIC HEATER REGULATOR AND PROTECTOR "A4"

DIMENSIONS ARE IN INCHES
TOL: .XX ± .015, .XXX ± .005, ANGLE ± ½°
UNLESS INDICATED OTHERWISE

ALFRED ELECTRONICS
PALO ALTO, CALIFORNIA

SIZE C | 900911 | REV D

SHEET 1 OF 1